

# ELECTRICAL CONSTRUCTION AND MAINTENANCE

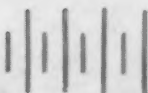
MAY • 1955

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## *Electrical Specifications Issue*



A master specification for electrical construction and installation designed for use as a guide, prototype or reference in the preparation of project specifications, job descriptions, inquiries, recommendations and proposals.

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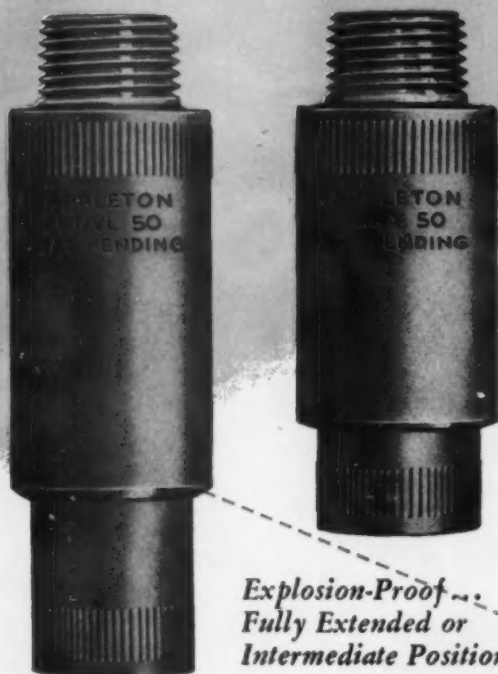
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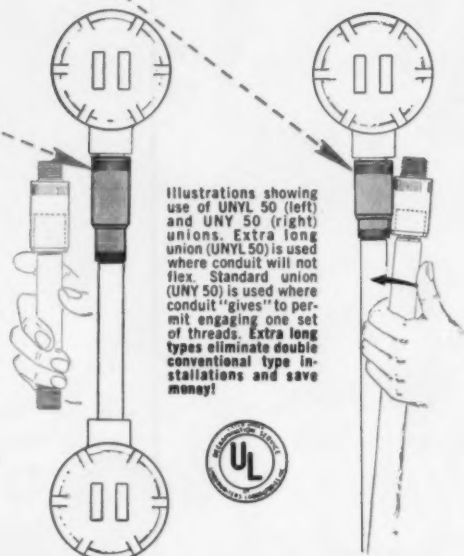
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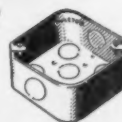
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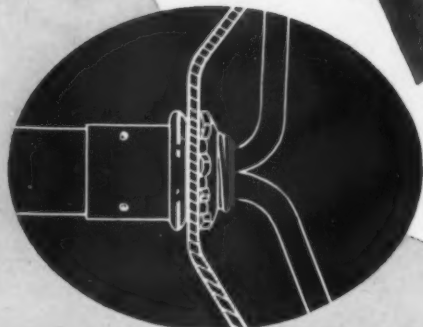
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# Washington Report

**Continued boom in business** through last half of 1955 is being predicted by most government economists, as reports of first half of year activities continue to set new records. Gross national product (GNP) in 1st quarter was at record \$369 billion annual rate, over previous peak in 1953 of \$364 billion rate. Steel mills report orders for 3rd quarter bookings are sizable, construction rate continues at new record high, large order backlogs for new cars reflect need for continued high rate of production on 1955 models. Biggest threat to the economy in months ahead, it is felt, is possibility of UAW strike against GM or Ford in June or soon thereafter.

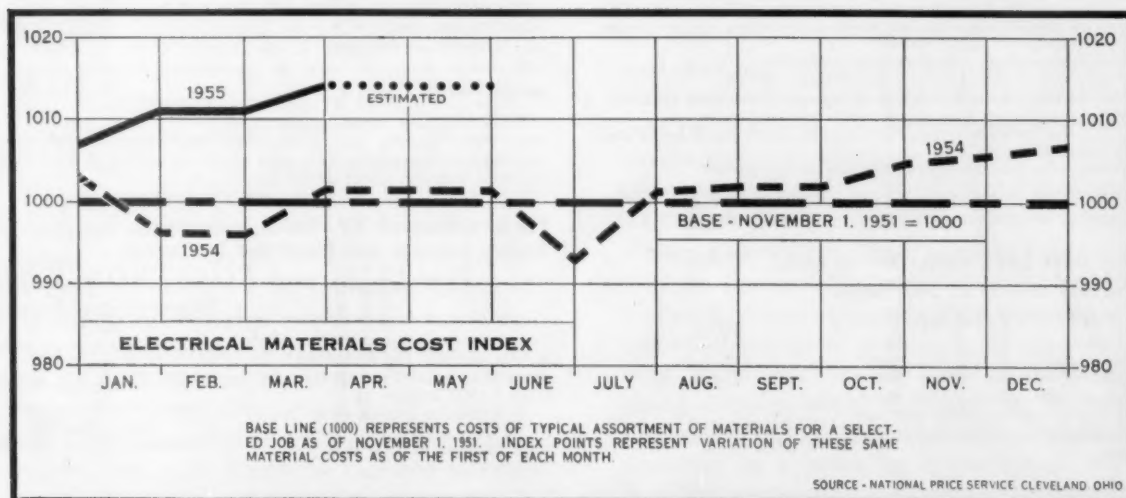
**Personal income has risen** to annual rate of \$292.4 billion, up \$7.4 billion over rate in February 1954, as total employment reached a mid-March total of 60,477,000 or 539,000 more than a month earlier.

**Capital expenditures** for new plant and equipment during this quarter are expected to reach \$7 billion, up about \$100 million over similar period last year, Dept. of Commerce reports. Estimated total for 1955 is \$27.1 billion, or \$300 million more than for all 1954. (This compares with a record \$29.6 billion total predicted in mid-April by McGraw-Hill's Economics Dept., based on its annual survey of business' plans).

**More highway spending is in prospect** starting July 1st. Under existing law, federal aid will rise from \$575 million to \$875 million annually. A long-term plan of \$101 billion in highway expansion over next ten years) to take care of the increasing number of autos on the road each year has been proposed by President Eisenhower, but this plan has not received broad backing in Congress due to disagreement over methods of financing.

**Tighter terms for FHA-insured loans** have been urged on Congress by a Joint Committee on Economic Policy, representing trade groups for the nation's life insurance companies, "to curb inflationary pressures of excessively easy credit" which is permitting the current "residential construction industry to draw on future demand", it points out. Housing starts in March were at an annual rate of 1.4 million, and showed no evidence of weakening.

**The 90¢-an-hour minimum wage**, to cover some 800,000 workers in various industries now earning less, is being pushed by Labor Secretary Mitchell for the Administration, seems sure to pass Congress this spring. Unions are demanding \$1.25 an hour, and industry groups are opposing any rate increase—but both are expected to be satisfied with a 90¢ an hour rate.





# There's a BUSS Fuse or FUSETRON Fuse to fit the needs of every user

If you want Non-Renewable Fuses . . .

## Use BUSS One-Time Fuses

They save you time and trouble because they get the same engineering care in manufacture as do all products carrying the BUSS Trademark.

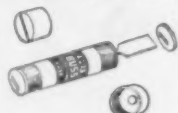
Every BUSS One-Time fuse can be depended upon to operate as intended under all service conditions.



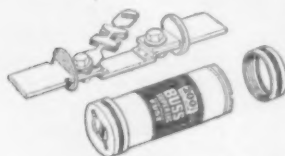
If you want Renewable Fuses . . .

## Use BUSS Super-Lag Renewable Fuses

The big advantage of these fuses over all other renewable fuses comes from the prevention of useless interruptions of service caused by needless blows.



The reasons for this performance is found in the design of the fuse-case which assures good contact on the fuse link, even if the fuse is renewed by an inexperienced person — and by the time-lag built into the link that prevents the fuse from opening on motor starting currents or other harmless overloads.



If you want fuses that — abolish all needless blows, stop overheating in panels and switches, protect motors against burnout . . .

## Use FUSETRON dual-element Fuses

With rare exceptions, ordinary fuses or circuit breakers do not protect except against short-circuit but FUSETRON fuses provide TEN POINT protection.



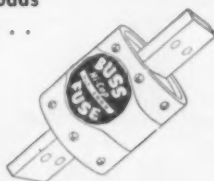
1. Protect against short-circuits.
2. Protect against needless blows caused by harmless overloads.
3. Protect against needless blows caused by excessive heating—lesser resistance results in much cooler operation.
4. Provide thermal protection—for panels and switches against damage from heating due to poor contact.
5. Protect motors against burnout from overloading.
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9. Protect against waste of space and money—permit use of proper size switches and panels.
10. Protect coils, transformers and solenoids against burnout.

FUSETRON dual-element FUSES save you time and money because they are made to PROTECT — not to blow.

If you want SAFE protection on loads above 600 and up to 5000 amps . . .

## Use BUSS Hi-Cap Fuses

On voltages up to 600, high speed operation on heavy shorts limits current to safe values. This minimizes damage to equipment and cuts down dangerous stresses on transformers.



If you want Plug Fuses . . .

## Use BUSS Clear Window Plug Fuses

Their one-piece body and "safety" design guarantees protection.

They are most convenient to use too, because real big window and white backgrounds permits entire fuse strip to be seen. Even in poor light a blown BUSS fuse is easy to find.



If you want to reduce blowing of plug fuses . . .

## Use FUSETRON dual-element Plug Fuses

FUSETRON Plug fuses protect like ordinary fuses against short-circuits and overloads — but unlike ordinary fuses they won't blow on motor starting currents or other harmless overloads.

They are the type of fuses recommended in the 1953 National Electrical Code.



If you want to make safe protection REMAIN SAFE as well as REDUCE blowing of fuses . . .

## Use BUSS Fustats (have Type S base)

FUSTATS like Fusetron Fuses have a dual-element and therefore, stop needless blowing — and they do more.

They have a type S base that prevents anyone from replacing them with a penny or substitute — or using a size too large to protect.



FUSTATS fit standard plug fuse holders by means of an inexpensive adapter that locks in place and needs never to be replaced.

To protect motors and apparatus of voltages up to 125 against burnout . . .

## Use 0 to 14 ampere BUSS Fustats

A FUSTAT of the proper size installed to handle only the motor current will reduce to a minimum the chance of a motor burnout from any excessive over-current. In like manner it will protect solenoids, coils or transformers against burnout.



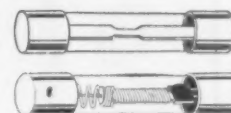
FUSTATS have the same degree of Underwriters' approval for both motor-running and short-circuit protection as the most expensive devices made. They give all the protection it is possible to obtain with any device on the market.

For protection of TV, Radio, Instruments, Radar, Avionics and Electronic Equipment . . .

## Use BUSS and FUSETRON Small Dimension Fuses

A complete line is available. Made in Dual-element (slow-blowing), Renewable and One-Time types in sizes from 1/500 ampere up.

And there is a companion line of BUSS Fuse Clips, Fuse Blocks and Fuse Holders to take them.



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**FINANCIAL AID TO HIGHER EDUCATION**

# **Business Help for Our Colleges A Job for All Business Firms**

**IN** recent months, individual business firms have announced the adoption of a variety of plans, both imposing and ingenious, for financial aid to higher education in the United States. In doing so, they have taken a lead in dealing with a problem of transcendent importance both to the business community and to our nation as a whole.

Previous editorials in this special series have shown that:

1. Our colleges and universities, and particularly the independent, privately endowed institutions, are in grave financial difficulties.

2. These difficulties promise to become much more acute in the years immediately ahead unless extraordinary steps are taken to relieve them.

3. A financially crippled system of higher education is a major national menace.

**If, however, the business community is to play an adequate part in helping our colleges and universities financially, the plans adopted by business firms thus far constitute merely a beginning and a set of guide posts. What is required is a general movement on the part of business firms to go to the financial aid of higher education. Such a movement would involve a myriad of individual company plans which, in the nature of the case, cannot be expected to bring great renown or publicity to their sponsors.**

## **Rescue Operation Is Feasible**

For the business community as a whole it is feasible to make a major and possibly a decisive contribution to putting our colleges and universities back on their feet financially. One percent of business profits before taxes would do it. In 1954 business profits before taxes were about \$35 billion. If one percent of these profits, or \$350 million, were contributed to our independent, privately endowed colleges and universities it would enable these institutions (1) to increase the salaries they pay by \$200 million a year, and (2) to provide \$150 million more for modernization and maintenance of their establishments. In the opinion of competent authorities, this would put these institutions in relatively good working order financially, a process to which a matching grant of \$50 million by the Ford Foundation for the improvement of faculty salaries will make a large contribution. It would add about one-fourth to their present annual outlay of about \$1.4 billion.

Such a contribution from business would not meet the needs of the independent institutions for new buildings and equipment required to accommodate the great increase in college enrollment anticipated in the years immediately ahead. Neither would it relieve the financial problems of our tax-supported colleges and universities. As a group these institutions have fared better financially in recent years than the

independent institutions. But they also face grave financial problems, particularly in the provision of adequate faculty salaries. It would be far simpler, however, to solve the financial problems of the tax-supported institutions if the independent colleges and universities were back on their feet financially.

### One Dollar Does Work of Two

The federal government exempts 5 percent of business profits from the tax imposed upon them if the 5 percent is devoted to religious, charitable or educational purposes. (Most profits are taxed 52 percent.) A contribution of one percent of business profits to higher educational institutions would exhaust only one-fifth of this allowance. It would bring to about two percent the total share of business profits going to both educational and charitable purposes.

In 1953, business firms contributed about \$400 million, or slightly more than one percent of profits before taxes to educational and charitable purposes of all kinds. Of this total about \$75 million went to educational institutions, mostly colleges and universities.

For some companies it is feasible to contribute more than the average contributed by business generally. Indeed, some companies not only utilize their full 5 percent of tax-deductible funds for charitable and educational purposes but go beyond it. For other companies in financial difficulties no contribution at all is possible.

If, however, those business firms for which it is financially feasible contributed one percent of their profits before taxes to our colleges and universities, the problem of adequate support for the crucially important business of higher education would be far along the way to successful solution. **In 1954 a contribution of one percent of their profits before taxes, or about \$350 million, would have reduced business profits after taxes by only about half that amount. This would have meant a reduction of about \$175 million, out of a total of about \$17.8 billion of profits after taxes.**

Attractive plans to channel financial aid from business to higher education have been abundantly demonstrated recently. These plans, for the most part the creation of large corporations, have included not only a broad array of schol-

arship grants, but such ingenious arrangements as that by which a company matches with its funds the gifts its employees make to the colleges of which they are alumni.

A full array of these plans, some of which were discussed in an earlier editorial in this series, has been prepared by The Council for Financial Aid to Education (6 East 45th Street, New York City 17) and is available for the asking. Also, colleges and universities have established in most states and regions cooperative associations to help business help them. The Commission on Colleges and Industry (912 Kahn Building, Indianapolis 4, Indiana) distributes a directory of these associations. And, of course, the colleges themselves are always eager to discuss their financial problems with business people and suggest constructive solutions.

### Only Small Start Made

The plans for business aid to education which have recently attracted national attention constitute the conspicuous sort of leadership which it is the privilege and opportunity of our great corporations to provide. But the job is too large to be handled by a small number of business firms, no matter how bold or ingenious their programs.

**To put our colleges and universities back on a firm footing financially the help of the great rank and file of business corporations is required. All of them, large and small, have a crucial stake in seeing that this job is done. The future of America will be decisively shaped by what happens in and to our college classrooms.**

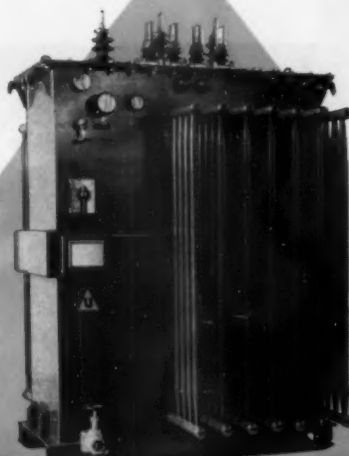
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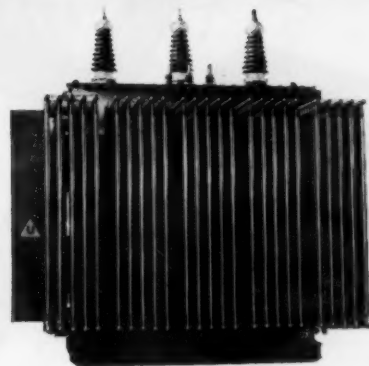
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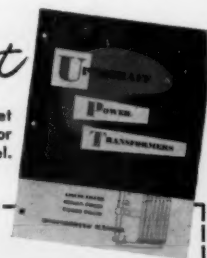


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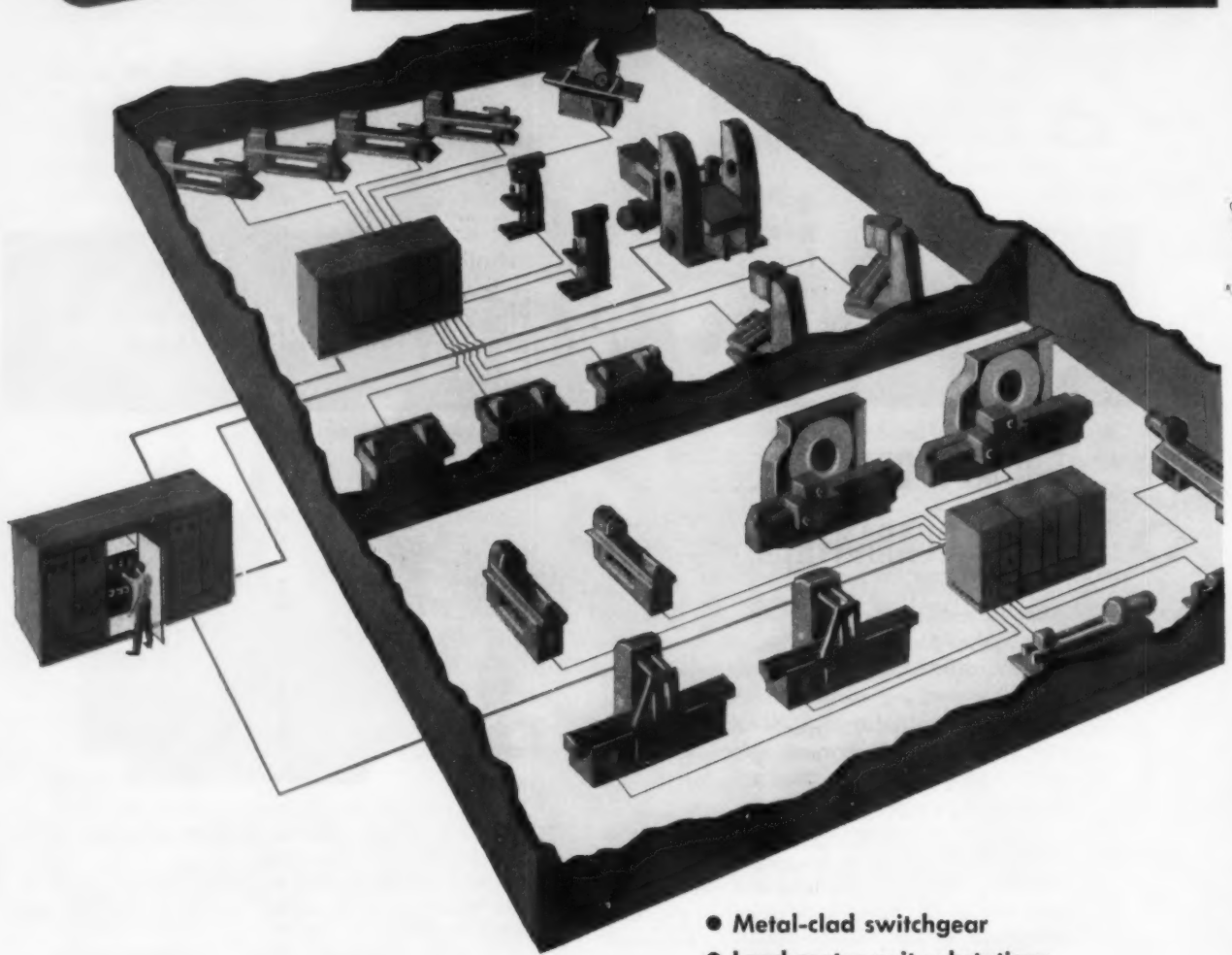
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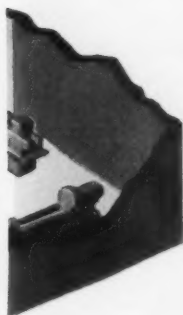
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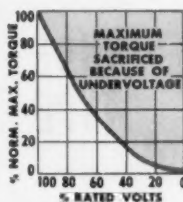
# electrically

## Cut Operating Costs 6 Ways — Improve Distribution System With Allis-Chalmers Switchgear

In many plants the electrical system grew piecemeal. New machines were added to existing feeders; long low-voltage feeders were added for new groups of machines — and the whole system became inefficient and even dangerous. If this is the case, here are some of the losses to be avoided by modernizing with Allis-Chalmers switchgear:

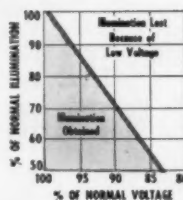


**1 Torque loss** — Torque and horsepower drop when voltage drops below rated voltage of motors. Jobs take longer, because reduced torque necessitates lighter cuts on machine tools. Major cause of undervoltage is long, low voltage feeders. Placing unit substations at load centers shortens low voltage cable . . . improves voltage.



### 2 Illumination loss

— You get less lumens per dollar when voltage is low. In addition, most studies show workers see better, produce more when illumination level is high.



**3 Production loss** — Standard Allis-Chalmers switchgear designed to accom-

modate special circuit schemes that will assure uninterrupted power for automation or continuous processing.

**4 Motor burnout** — Individually enclosed low voltage circuit breakers at each machine protect motors from faults and from overloads that might cause burnouts . . . protects you from lengthy interrupted production.

**5 Space loss** — Compact Allis-Chalmers switchgear units fit anywhere. Use non-productive areas such as the roof, basement, balcony or space outside near the building.

**6 Power loss** — Old breakers in many plants are now inadequate to handle a short circuit because of increased system capacity since the time they were installed. A major fault could cause equipment failures and prolonged outages. If your plant is typical, any breaker over 10 years old is probably inadequate today, because of your increased use of power.

get more information



Allis-Chalmers switchgear engineers can help you solve your electrical distribution problems. Call your nearby A-C district office, or write for further information.

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# Standard and Special Motors for Almost Every Purpose

ON THIS CHART YOU WILL FIND a standard type Allis-Chalmers motor to fit nearly every need from ½ hp up. Many of them have exclusive construction features, such as fin cooling and tube cooling, which offer you premium performance without premium price.

And, of course, modifications from strictly standard designs can easily be made to fit your particular requirements.

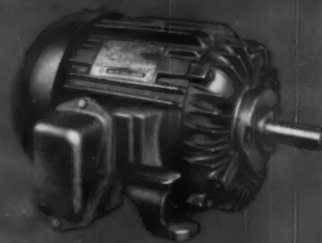
If you have a special problem, Allis-Chalmers will gladly furnish experienced engineers to help you work out your motor problems. Allis-Chalmers engineers are particularly helpful because A-C's strong background in control, drives and many types of driven machines gives them an especially intimate knowledge of motor requirements.

A-4746

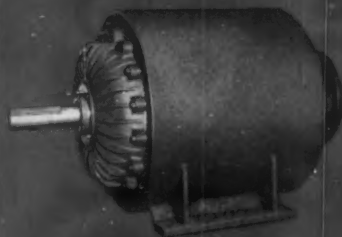
**DRIP-  
PROOF**



**TEFC  
and  
EXPLOSION-  
PROOF**



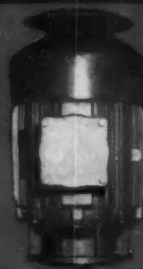
**TUBE  
TYPE**



**GEAR  
MOTORS**



**VERTICAL**



# ALLIS-

### **RANGE**

1/2 to 800 hp. 450 to 3600 rpm. 208, 220, 440, 550 volts. Frame 182 to 326 in Type G construction. Frame 364 to 445 in Type AP construction. Frames 504 and larger in Type AW construction.

### **CONSTRUCTION**

Stator yokes for Type G and AP motors are cast iron. Type AW motors are built with cast steel yoke heads with integral mounting feet and heavy continuous

welded steel drip covers. Stator slots are semi-closed for the smaller sizes, open type with form-wound coils for the larger sizes. Windings are multiple dipped and baked. Rotors are cast aluminum with integral fans. Copper or copper alloy with brazed end rings is used for some ratings. Bearing end shields are cast iron. Ball bearings are available in all sizes. Sleeve bearings in some larger sizes.

### **MODIFICATIONS**

Basic motor is open drip-proof rated 40°

C continuous, NEMA Design B. Design A, C and D motors also are available. Other electrical modifications include 110 volts on frames 326 and smaller and 2300 volts on frames 445 and larger, and multi-speed motors with constant torque, variable torque and constant horsepower. Mechanical modifications include splash-proof construction, rated 50° C continuous. Other modifications, both mechanical and electrical, can be made to suit your specific requirements.

### **RANGE**

1/2 to 100 hp. 600 to 3600 rpm. 208, 220, 440, 550 volts. Frames 182 to 505 totally-enclosed, fan-cooled and explosion-proof construction.

### **CONSTRUCTION**

Special non-clogging design blows itself clean, is easy to wipe or blow off if oily or moist dirt sticks.

External fan and fan shields circulate and direct air over the motor enclosure. Stator yoke is ribbed cast iron, designed for easy cleaning. Stator winding is the same as in open types. Bearing end shields are ribbed cast iron. Ball bearings are used except for 75 and 100-hp, 3600-rpm motors, which have split sleeve bearing construction.

Explosion-proof motors have extra deep

rabbeted housing fits and bearing seals. All seals are metal to metal.

### **MODIFICATIONS**

Basic motor is totally-enclosed fan-cooled, rated 55° C continuous, NEMA Design B. Design A, C and D motors also are available. Same electrical modifications are available as in open types. Approved by Underwriters for Class I, Group D and Class II, Group E, F and G hazards.

### **RANGE**

40 to 2500 hp. 600 to 3600 rpm. 208, 220, 440, 550 volts plus higher voltages in larger sizes.

### **CONSTRUCTION**

Ventilating system is simple but highly efficient. The frame is surrounded by a nest of tubes. Internal fans circulate the inside air around the tubes, while an external fan drives outside air through tubes to dissipate the heat. This arrangement permits full internal air circulation. Cleaning is easy but seldom necessary. Stator

yoke is heavy fabricated steel plate construction. Cooling tubes are generally copper but may be of other materials. Rotor construction is determined by speed, rating, and application. Bearing end shields are heavy cast iron, with internal and external ribs. Sleeve bearings available in all sizes, ball bearings in most. Explosion-proof motors differ from standard enclosed machines only in details.

### **MODIFICATIONS**

Basic motor is totally-enclosed, fan-cooled rated 55° C continuous, NEMA Design

B. Design A, C and D motors also are available. Same electrical modifications are available as in open types. Mechanical modifications include explosion-proof construction in most sizes up to 1250 hp at 3600 rpm. Approved by Underwriters for Class I, Group D and Class II, Group F and G hazards. Cooling tubes may be made of any material to withstand corrosive action of refinery vapors, fly ash, and other air-borne corrosives. This motor available in vertical mounting type in all sizes.

### **RANGE**

7.5 to 520 rpm with 1750-rpm motors. 1 to 50 hp. 206, 220, 440, 550 volts. Horizontal or vertical types.

### **CONSTRUCTION**

Integral type uses round frame, D-flange motor, resulting in shorter overall length. All-motor type uses standard foot-mount-

ed motor—recommended whenever space permits. AGMA Class I, II, III gears for steady loads, moderate shock loads, and heavy shock loads respectively. Gears have compact, rigid, all-steel housings. Large shafts, husky bearings and strong bearing mountings resist severe loading. Heat treated alloy steel helical gears are lubricated by direct dip for safe continuous

lubrication, protected by heavy duty shaft seals.

### **MODIFICATIONS**

Any standard motor may be used with the complete range of mechanical and electrical modifications shown above. In addition, special designs can be built to meet special problems.

### **RANGE**

1/2 hp and up. 450 to 3600 rpm. 208, 220, 440, 550, 2300 and higher voltages. Frames 203 to 505 and up.

### **CONSTRUCTION**

Vertical motors with NEMA type P bases

are available in the same range of ratings as the AP, AW, and AZ types shown at left, including mechanical modifications such as totally-enclosed and explosion-proof construction. Construction features and electrical modifications are same as for standard horizontal motors.

### **MODIFICATIONS**

Special bearings for additional thrust carrying capacity are available in some cases. Where required special lubricating and grease retaining features are available.

# CHALMERS



MILWAUKEE 1, WISCONSIN

# ALLIS-CHALMERS CONTROL






ALLIS-CHALMERS offers a complete line of full voltage and reduced voltage motor starters to meet the requirements of any type of ac motor drive. This includes manual or magnetic, reversing or non-reversing, single or multi-speed controllers. These starters as well as push-button stations are available in practically every type of enclosure, such as general-purpose, watertight, dust-tight and explosion-proof.

Accessory control equipment includes dc contactors, timing relays, air and oil contactors for heavy duty starting and rotary control switches. Allis-Chalmers engineers have the specialized experience to coordinate your power utilization problems.

Allis-Chalmers motor controls give you maximum line-to-motor protection with highly efficient operation and low maintenance. Tested performance has already proved the superior service qualities of all Allis-Chalmers motor controls.

For more complete information on any specific control problem, call your nearby Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4747

	NEMA SIZE	VOLTAGE RANGE	MAX. HP	TYPE ENCLOSURES	DESCRIPTION
 Squirrel Cage Fractional Hp Single Phase	One or Two Pole	115-230	1	General-purpose, dust-tight, water-tight, explosion-proof.	For manual across-the-line starting of fractional hp single-phase motors.
 Squirrel Cage Manual Full Voltage	0 1	110-550 110-550	1½-2 3-7½	General-purpose, dust-tight, water-tight, explosion-proof.	For manual across-the-line full voltage starting and stopping of small squirrel-cage motors. Overload protection is provided but not undervoltage protection. Manual starters for single-phase fractional hp motors are also available.
 Squirrel Cage Magnetic Full Voltage	0 1 2 3 4 5 6 7	110-550 110-550 110-550 110-550 220-550 220-550 208-550 208-550	1½-2 3-7½ 7½-25 15-50 50-100 100-200 200-400 300-600	Sizes 0 to 4 are available in general-purpose, dust-tight, water-tight, explosion-proof, and open types; Sizes 5, 6 and 7 in all but explosion-proof.	For across-the-line starting and stopping where full starting torque and current inrush are permitted. As primary starting switches for wound-rotor motors where manual starting and speed regulation are provided in the secondary circuit. Overload and undervoltage protection is provided.
 Squirrel Cage Magnetic Full Voltage Combination Fusible, Non-fusible and Circuit Breaker	0 1 2 3 4 5 6 7	208-550 208-550 208-550 208-550 208-550 208-550 208-550 208-550	2 3-7½ 7½-25 30-50 50-100 100-200 200-400 300-600	Sizes 0 to 4, general-purpose, dust-tight, water-tight, explosion-proof; Sizes 4 and 5, circuit breaker type only, general-purpose, dust-tight, water-tight.	Same application as above. Includes fusible or non-fusible disconnecting switch or air circuit breaker. Overload and undervoltage protection is provided.
 Squirrel Cage Magnetic Full Voltage Reversing	0 1 2 3 4 5	110-550 208-550 208-550 208-550 208-550 208-550	1½-2 5-7½ 15-25 30-50 50-100 100-200	Sizes 0 to 4, general-purpose, dust-tight, water-tight, explosion-proof, Class II, Group G, open; Sizes 4, 5 and 6, all but explosion-proof.	For across-the-line starting, stopping and reversing of squirrel-cage motors where full starting torque and current inrush are permitted. Also available as combination reversing starters.



# ALLIS-



A-C TYPE	VOLTAGE RANGE	HP RANGE	DESCRIPTION
RMC RMC RMC	220 440-550 2000-2500	5-125 5-150 20-150	For starting squirrel-cage motors where it is desirable or necessary to reduce starting current inrush or starting shock. Overload protection by hand-reset temperature overload relays. Stop reset button on outside of case. Oil-immersed contacts. Built in general-purpose, semi-dust-tight, and explosion-proof NEMA 9. Also drip-proof hood available.
ARC ARC ARC ARC ARC	220 440-550 2000-2500 2501-4500 4501-5000	5-700 5-1000 20-2500 60-2500 300-2500	For applications similar to above but switches are ac electrically operated. Incomplete sequence relay is provided for transformer protection. Definite time transfer relay is adjustable. Overload protection by hand-reset thermal relays. Undervoltage device for starters above 600 volts has time delay. Built in general-purpose, semi-dust-tight and outdoor NEMA 3 enclosures. NEMA 4 water-tight and NEMA 5 dust-tight enclosures are available to 600 hp, 600 volts max.
5832 5832	220 440-550	5-300 5-600	For non-reversing, and reversing service. Interrupting rating ten times motor full-load current. Resistor class 116 for general starting duty and resistor class 136 for high inertia starting duty. Definite time, adjustable, motor-driven transfer relay. Thermal overload relays are hand set. Three-pole line and accelerating contactors are ac electrically operated. Built in general-purpose, semi-dust-tight, water-tight and dust-tight enclosures. Two-step increment starters for part winding motors are also available.
ALW ALW ALW ALW	220 440-550 2000-2500 2501-4500	5-500 5-1000 20-1000 60-1000	For motors driving pumps, fans, compressors, conveyors, crushers, etc. Approximately 200 percent full-load motor torque and current obtained on first point of acceleration. Thermal overload and undervoltage protection included. Available for reversing service. Standard starters are NEMA 1 general-purpose enclosed. Also available in semi-dust-tight as well as outdoor NEMA 3 enclosures. NEMA 4 water-tight and NEMA 5 dust-tight enclosures are available up to 600 hp, 600 volts max.
5852	1000 Max.	5-750	Controls secondary circuits of wound-rotor motors driving pumps, blowers, crushers, kilns, and similar non-reversing applications. They are used with a suitable primary circuit switch. General-purpose or semi-dust-tight enclosures.
ARS ARS ARS ARS ARS MRS MRS MRS ALS ALS ALS ALS ALS	220 440-550 2000-2500 2501-4500 4501-5000 220 440-550 2000-2500 220 440-550 2000-2500 220 440-550 2000-2500 2501-4500 4501-5000	25-300 25-1750 25-3000 60-3000 200-3000 20-150 20-175 20-175 20-175 25-300 25-1750 25-3000 60-3000 200-3000	These starters feature: positive synchronizing, full motor protection, maximum accessibility, easy adjustment, and long life. Application and removal of dc field excitation is automatic. Magnetic starters use magnetically operated power starting devices. The semi-magnetic type is furnished for reduced voltage service only. Starters use the new type 230 polarized field frequency field application and removal relay and have these protective features: overload, undervoltage, pullout protection, and shut-down in case of incomplete starting sequence. Standard starters are NEMA 1 general-purpose enclosed. Also available in semi-dust-tight as well as outdoor NEMA 3 enclosures. NEMA 4 water-tight and NEMA 5 dust-tight enclosures are available up to 600 hp, 600 volts max.
HALC HALC HARC HARC HALS HALS HALS HARS HARS HALW HALW	2300 4160-4600 2300 4160-4600 2300 4160-4600 2300 4160-4600 2300 4160-4600 2300 4160-4600	To 1250 To 2250 To 1250 To 2250 To 1500 To 2500 To 1500 To 2500 To 2500 To 700 To 1250	Enclosed magnetic full and reduced voltage starters with high interrupting capacity current-limiting disconnecting type fuses. Can be connected directly to circuits requiring up to 150,000 kva interrupting capacity at 2300 volts and 250,000 kva at 4160 or 4600 volts, without the necessity of a back-up circuit breaker. High capacity fuses limit short circuit current to a low, safe peak value. Available with choice of air or oil starting contactors. Standard units are NEMA 1 general purpose enclosed. Also available in semi-dust-tight and NEMA 3 outdoor enclosures. Maximum ratings are with air break contactors. Ratings are slightly less with oil-immersed contactors.

Squirrel Cage  
Manual  
Reduced Voltage  
Auto-Transformer



Squirrel Cage  
Magnetic  
Reduced Voltage  
Auto-Transformer



Squirrel Cage  
Magnetic  
Reduced Voltage  
Primary Resistor



Wound Rotor  
Magnetic  
Primary and  
Secondary Control



Wound Rotor  
Drums and Resistors  
for Secondary  
Control



Synchronous  
Reduced Voltage  
Magnetic



Synchronous  
Reduced Voltage  
Semi-Magnetic



Synchronous  
Full Voltage  
Magnetic



High Capacity  
Induction, Mag.  
Full Voltage  
Induction, Mag.  
Reduced Voltage  
Synchronous, Mag.  
Full Voltage  
Synchronous, Mag.  
Reduced Voltage  
Wound Rotor, Mag.  
Prim. & Sec.

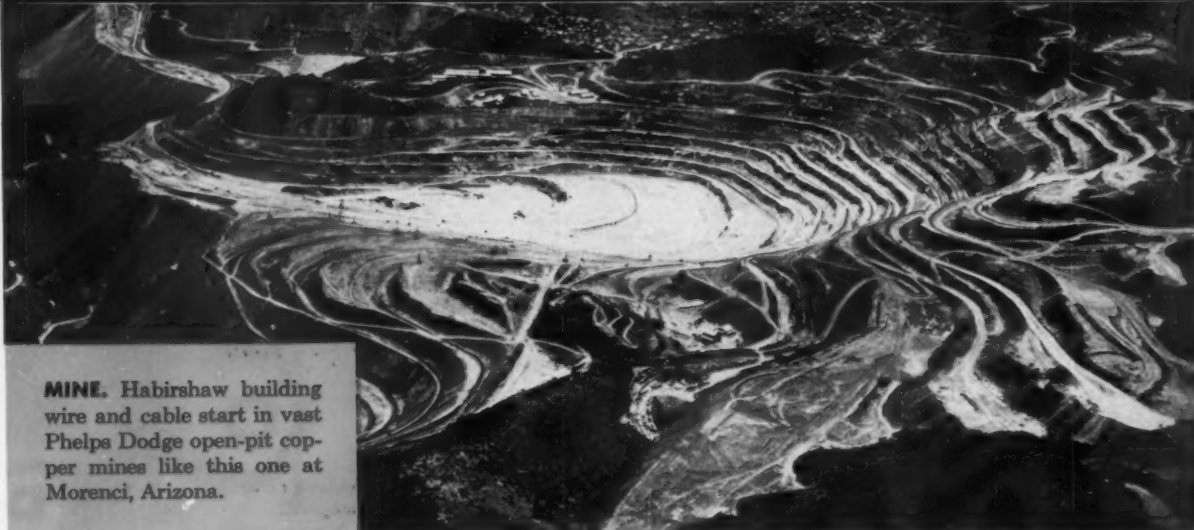


# CHALMERS

MILWAUKEE 1, WISCONSIN



*When you need a dependable source*



**MINE.** Habirshaw building wire and cable start in vast Phelps Dodge open-pit copper mines like this one at Morenci, Arizona.

## IT PAYS TO SEE A PHELPS



**MARKET.** Delivery of Habirshaw building wire and cable by Phelps Dodge distributors to job site is final step in unified "Mine to Market" operation.

*of supply...*



**MANUFACTURE.** Expert workmanship, careful quality control, rigid inspection mark the manufacture of building wire and cable at Habirshaw plant of Phelps Dodge Copper Products Corporation at Yonkers, N. Y.



## **DODGE DISTRIBUTOR!**

Phelps Dodge's complete "Mine to Market" program assures distributors dependable supplies and service

Here's what "Mine to Market" means to you:

- 1. A CONSTANT SUPPLY OF RAW MATERIALS.**
- 2. HIGHEST QUALITY WORKMANSHIP.**
- 3. PROMPT DELIVERY — all from one major source.**

Phelps Dodge distributors are an integrated part of this system, profit from working closely with a primary copper producer and fabricator.

***PHELPS DODGE COPPER PRODUCTS***  
**CORPORATION**

**WIRE BY PHELPS DODGE MEANS WIRED FOR LIFE!**

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*Cope*

EFFICIENCY...

**COPE 70,000 SERIES CABLE TROUGH  
WITH THE BUILT-IN COUPLER  
now available in 12' length  
33% fewer connections**



The new Cope 70,000 Series Cable Trough with the built-in Coupler is now available in 8, 10, and 12 foot lengths, and affords you 80% SAVINGS in assembly time, PLUS 33% FEWER CONNECTIONS.

These features alone mean real savings for you, in time and money.

\*PATENT  
PENDING

*Cope*

**T. J. COPE, INC.**

**711 SOUTH 50th ST., PHILADELPHIA 43, PA.**

# Bogen

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BECAUSE IT SOUNDS BETTER

TRANSFORMERS  
ARE INSULATED

*with*

**NATVAR**

**Straight Cut V.C.**



With the new Bogen R-763 Auto-Lock Tuner, you simply tune until you hear the FM station you want. Then the R-763 automatically "zeros in" to optimum adjustment and locks into position.



Operator of this multi coil winder finds it easy to insert Natvar V.C. as interwinding insulation, because it is always pliable and never sticky.



Lends are dead soft, but are easily inserted in Natvar Varnished Fiberglass Sleeving because it is so smooth inside. Operator slips sleeving back while stripping the enamel before hot tin dipping.



## Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglass
- Varnished papers—rope and kraft
- Slat cell combinations, Aboglas®
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 23

**T**HE DAVID BOGEN CO., INC., manufactures high fidelity home music systems of highest quality. Their matched tuners, amplifiers, record players and accessory units are noted for their flat frequency response over the entire audio range, minimal distortion, and other features such as the Bogen Auto-Lock tuning circuit to simplify tuning and eliminate drift.

Engineering and design are up to the minute, and components are carefully built of the best of suitable materials. Natvar straight cut varnished cambric is used as transformer interwinding insulation because "it is soft, pliable, and easy to handle, of uniform thickness throughout the sheet, with no thin spots. It is consistently good. Each shipment is exactly like the last."

Natvar flexible insulations are uniformly dependable no matter where or when purchased. They are available either from your wholesaler's stock or direct from our own.

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### ARCHITECT'S ELECTRICAL SPECIFICATIONS may be written to include ELECTRUNIT E.M.T. by adding the following:

"Electrical conductors may be enclosed in Republic ELECTRUNIT E.M.T. or equal as provided in the National Electrical Code. Electrical Metallic Tubing shall be steel, electrically welded, galvanized and produced in accordance with Underwriters' Laboratories' Standards and so labeled. For U. S. Government jobs, use Federal Specification WW-T-806, latest revision.

"Couplings and box connectors shall be rain and concrete tight, Underwriters' Approved, and so listed."

### meet all these standard

You're safe . . . and you're sure . . . when you specify and buy genuine Republic ELECTRUNIT Electrical Metallic Tubing—the original lightweight rigid steel raceway.

Republic ELECTRUNIT is produced in accordance with standards of *Underwriters' Laboratories, Inc.*, and is so labeled. It is furnished in accordance with *American Standards Association* Specifications. It meets *Federal Specifications*, and is approved by the *National Electrical*



"INCH-MARKED"

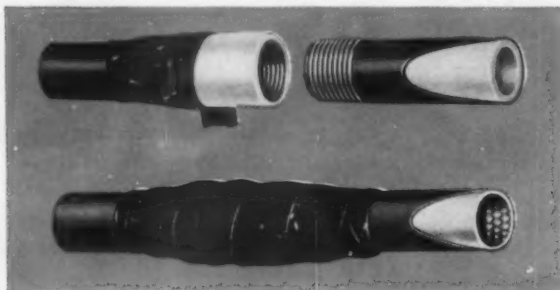
FULL-LENGTH "GUIDE-LINE"

KNURLED INSIDE SURFACE

NO THREADS TO CUT

### EXTREME CORROSIVE CONDITIONS?

Specify Republic® Dekoron-Coated®  
E.M.T. or Rigid Steel Conduit

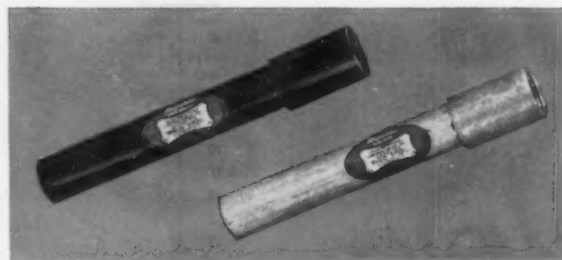


Both types are coated with corrosion-resistant polyethylene .020" thick. Properly installed, "Dekorons-Coated" E.M.T. and Rigid Steel Conduit give continuous corrosion-free protection from outlet to outlet.

ELECTRUNIT "DEKORON-COATED" E. M. T. is easy to install, requires no special techniques, no special tools, no special fittings. It offers all the installation advantages and built-in qualities of ELECTRUNIT E. M. T. plus remarkable corrosion resistance.

REPUBLIC "DEKORON-COATED" GALVITE RIGID STEEL CONDUIT is available for corrosion-resistant installations where conditions or code requirements necessitate the use of heavy wall conduit. Galvite is hot dip galvanized inside and out, with baked-on lacquer for further protection before the Dekorons coating is applied. Sizes ½" to 6" inclusive.

### Republic Rigid Threaded Conduit Meets Standard "Specs"



Both types—GALVITE and ENAMELITE—are made from soft, ductile steel and produced by the continuous weld process. Both are thoroughly tested and inspected—including inspection by Underwriters' Laboratories, Inc. Republic Rigid Conduit meets Underwriters' Laboratories, Inc. Standards, American Standard Specifications, and Federal Specifications, WW-C-581 for GALVITE, WW-C-571 for ENAMELITE.

Republic Rigid Threaded Conduit offers a high degree of uniformity; extraordinarily high ductility; absolute freedom from "burnt" or hard spots; clean, sharp, free-running threads; sound, smooth, strong welds; galvanizing which will not peel or flake under normal bending.

GALVITE (Blue Label) is hot dipped galvanized inside and out and has a special coat of baked-on lacquer inside and out for further corrosion resistance and long life.

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# STEEL CONDUIT

## specifications...

Code for concealed, open and concrete construction.

You get *certified* protection. Where written certification is required, Republic Steel will furnish a notarized statement that Republic ELECTRUNITE E.M.T. is produced to and meets any of these specifications. That's important on government jobs.

When you buy, insist on Republic ELECTRUNITE E.M.T.—the E.M.T. that meets all standard specifications. Every foot is sold through electrical distributors.



LIGHTWEIGHT

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### ELECTRUNITE E.M.T. Dimensions and Weights

Trade Size (Inches)	Outside Diameter (Inches)	Nominal Inside Diameter (Inches)	Nominal Wall Thickness (Inches)	Minimum Weight per 100 Feet (Pounds)	Feet per Bundle
3/8	0.577	0.493	.042	23	200
1/2	0.706	0.622	.042	28.5	100
3/4	0.922	0.824	.049	43.5	100
1	1.163	1.049	.057	64	100
1 1/4	1.510	1.380	.065	95	50
1 1/2	1.740	1.610	.065	110	50
2	2.197	2.067	.065	140	30

\* Furnished with knurled inside finish.

† "INCH-MARKED" and "GUIDE-LINED"

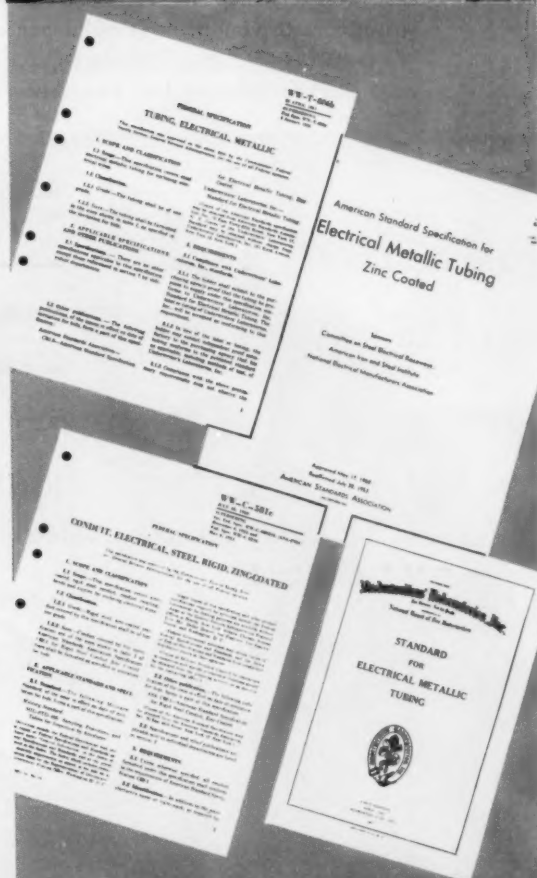
All sizes furnished in 10-foot lengths.

Applicable Tolerances—Length:  $\pm \frac{1}{4}$  inch.

Outside Diameter:  $\pm .005$  inch.

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*World's Widest Range of  
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Steel and Tubes Division  
212 East 131st Street  
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☐ Republic Rigid Steel Conduit  
☐ Republic "Dekor-on-Coated" Conduit E. M. T.  
☐ Republic "Dekor-on-Coated" Rigid Steel Conduit

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K-8480

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When you do, come to Auth . . . and buy buzzers, chimes, horns and sirens too. A complete variety is available, from midget buzzers that whisper "Come in, Miss Smith", to giant gongs that clang "FIRE! Get out!". They're easy to install and provide rugged, trouble-free operation with a minimum of maintenance. Get your copy of handy Audible Signals Catalog No. 105 by writing to: *Auth Electric Company, Inc., Long Island City 1, N. Y.*



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hospitals, housing, schools and industry.



QUALITY-CONTROLLED

# SPANG<sup>®</sup> CONDUIT

*... is easy to cut ... is easy to bend ... is easy to thread*



*... is easy to work with ... saves you installation time*



*... saves you money ... has high corrosion-resistance*



*... assures top-quality installations ... offers years of dependable service in any type of installation*

Take your choice of SPANG Hot Dipped Galvanized, SPANG Black or SPANGLEAM EMT. They're all *top-quality* products.

Your local SPANG Distributor carries the complete line of SPANG Conduit and fittings. He'll give you *top-quality* service, too.

Write for complete information and for the name of your nearest SPANG Distributor.



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# PICK THE RIGHT CORD FOR YOUR JOB!

Now—Anaconda introduces new portable cords with rugged construction . . .  
peak performance . . . and top flexibility for 3 types of service!

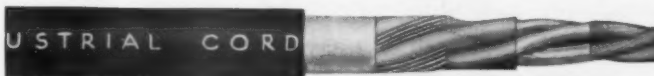
Severe applications . . . Hard usage . . .  
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type of job—strength, flexibility and resist-  
ance to wear!

Select the cord *best suited* to your needs—  
based on good engineering and sound  
economics.

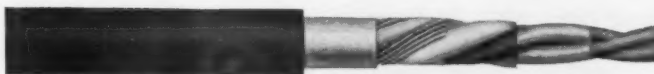
Whichever cord you choose, the Anaconda  
trademark is your assurance of *premium*  
performance.



**SECURITYFLEX**—Underwriters' approved Types SO and SJO.



**INDUSTRIAL**—Underwriters' approved Types SO and SJO.



**SERVICE**—Underwriters' approved Types S and SJ.

**SECURITYFLEX\* CORDS** for severest conditions. Toughest, sturdiest cords made . . . used where strength and wear-resistance are a "must." Neoprene jacket *mold-cured in lead* gives top crush, abrasion- and oil-resistance. Cords pay for themselves with long life under severest conditions—in mines, railroads, docks, and in heavy industrial use. Look for the molded-in name, "Securityflex!"

**INDUSTRIAL CORDS** for heavy industrial conditions and *maximum flexibility*. Lower in cost. Specially designed for use in heavy industry—where cords are in continuous operation and must be tough, flexible, oil-resistant. Tough neoprene jacket. Many industrials stock this one cord for use in virtually all applications . . . reducing inventory problems and costs. Look for the Anaconda marking on jacket.

**SERVICE CORDS** for regular duty. Lowest in cost . . . yet have many features found only in higher priced cords of other makes. Special rubber jacket withstands abuse and moisture. Outstanding for appliances, office machines, portable tools—where flexibility and long life are needed.

\*Reg. U. S. Pat. Off.

GG317

see the man from . . .

## ANACONDA®

about your

**PORTABLE CORDS**



### FREE "PORTABLE CORDS" BULLETIN

Anaconda Wire & Cable Company,  
25 Broadway, New York 4, N. Y.

Gentlemen: Please send me your new free  
"Portable Cords" bulletin, DM-5538.

NAME & TITLE.....  
COMPANY.....  
ADDRESS.....  
CITY, ZONE, STATE.....

Dollar Bank Savings and Trust Company, Youngstown, Ohio

AGENT: Graybar Electric Company



For a new catalog on the Wakefield Ceiling, Wakefield Geometrics and Wakefield luminaires of advanced design, write to The F. W. Wakefield Brass Company, Vermilion, Ohio. In Canada: Wakefield Lighting Limited, London, Ontario.

## GIVING A NEW LOOK TO THREE ROOMS IN A BANK WITH WAKEFIELD UNITS

by WILLIAM H. AXELSON,  
*electrical contractor*

*William Axelson used three different Wakefield large area lighting units to illuminate the newly remodeled executive suite of the Dollar Bank Savings and Trust Company, Youngstown, Ohio.*

### RECEPTION ROOM:

A continuous row of Wakefield 4' x 4' Beta recessed units in the main part of the room, with twin Beta units in the side offices. Multiple switching gives a range from 60 to 90 footcandles.

### BOARD ROOM:

Onto a curved ceiling 15 feet high went a continuous row of Wakefield 4' x 4' Omega surface-mounted units to form a pattern complementing the long board room table. Both Betas and Omegas have Rigid-Arch plastic diffusers.

### PRESIDENT'S OFFICE:

To top off the decorator's colorful and modern design, a Wakefield translucent ceiling was chosen to give evenly diffused illumination. Above the plastic diffuser are continuous rows of fluorescent lamps on 18 inch centers.

### PRAISE FROM MR. AXELSON

*"The styling and construction of Wakefield lighting fixtures makes them pleasing to the eye as well as easy to install. The supervisors on both installations remarked about the ease with which the fixtures were installed."*

Wakefield Congratulates WILLIAM H. AXELSON

# WAKEFIELD

VERMILION, OHIO

LONDON, ONTARIO



**ONE *Complete* SOURCE**  
**for the finest in**  
**ELECTRICAL EQUIPMENT**  
**for**  
**HAZARDOUS LOCATIONS**

**EXPLOSION-PROOF • DUST-TIGHT**  
**VAPORTIGHT • WATER-PROOF**

Design leadership, precision manufacture and rugged quality are three important features that make R & S electrical equipment for hazardous locations, the standard of comparison. Made of materials of outstanding quality, by highly skilled craftsmen, R & S electrical equipment is known and respected by architects, contractors, designers, engineers and maintenance men in all types of industries. Electrical wholesalers prefer to list and sell R & S equipment because these products create prestige, satisfy customers and promote greater sales. Feature for feature, item for item, there is nothing finer for hazardous locations than the R & S complete line.

If you are concerned with the proper application of electrical equipment to eliminate dangers in your hazardous locations, let R & S help you solve any problem.

*Sales Representatives in Principal Cities*



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**RUSSELL & STOLL**

PRECISION-BUILT ELECTRICAL EQUIPMENT—SINCE 1902

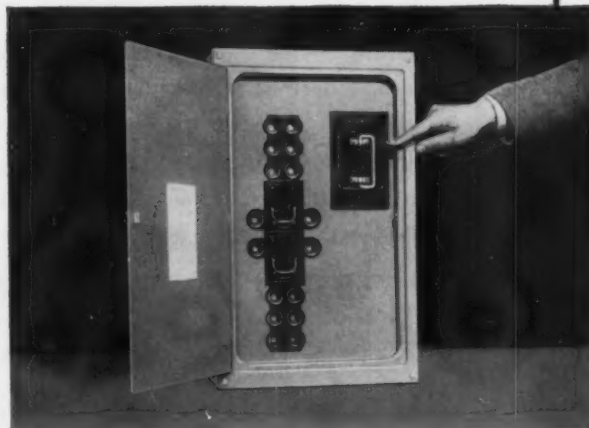


**G.E.'s 7 quality extras at no extra cost:**

- (1) Straight-in wiring for quick connections
- (2) Slide-out interiors—plenty of working room
- (3) Plenty of knockouts, properly located, easily removed
- (4) Silver-plated copper current carrying parts for cool operation
- (5) Snap-action fuse puller prevents partial contact
- (6) Narrow, shallow box construction simplifies flush installations
- (7) Bonderite\* finish to resist corrosion

\*Parker Rust Proof Company

**AVAILABLE SOON AT YOUR  
G.E. TRUMBULL DISTRIBUTOR**



100 amp series fuse puller combination, with 60 amp range and 30 amp branch fuse pullers; 12 or 16 plug fuse branches, Catalog Number TC 3217-16. Snap action pullers prevent partial contact. Quick, straight-in wiring—grips like a bear trap.



# G.E.'s new fuse puller line features slide-out interiors, straight-in wiring and five other quality extras at no extra cost

## Seven basic fuse puller devices designed to simplify your job from start to finish

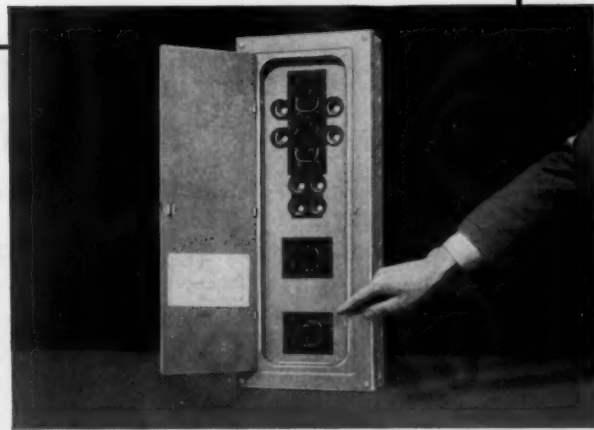
Here are 7 new G.E. fuse pullers—built with G.E.'s 7 quality extras for easier installations and better workmanship. Designs include parallel or series wiring and sealable pullers for independently metered equipment. U/L listed. Surface or flush mounted designs.

### Check this list, tear out the ad, and see your G.E. Trumbull distributor:

- ☐ 60 amp series main fuse puller only; up to 8 plug fuse branches.
- ☐ 60 amp series main and range fuse pullers (60 amp each); up to 8 plug fuse branches.
- ☐ 60 amp series main and range fuse pullers (60 amp each); one 30 amp independent sealable fuse puller; up to 8 plug fuse branches.
- ☐ 100 amp series main fuse puller, 60 amp range fuse puller and extra 30 amp fuse puller; 12 or 16 plug fuse branches.
- ☐ 100 amp parallel main and range fuse pullers (60 amp each); up to 8 plug fuse branches.
- ☐ 100 amp parallel main and range fuse pullers (60 amp each) and one 30 amp independent sealable fuse puller; up to 8 plug fuse branches.
- ☐ 100 amp parallel main and range fuse pullers (60 amp each), one extra 30 amp fuse puller and one 30 amp independent sealable fuse puller; up to 8 plug fuse branches.



60 amp series or 100 amp parallel fuse puller combinations, with 60 amp main and range pullers and 30 amp independent sealable puller, Catalog Numbers TC 2214-8 or TC 2219-8. Exclusive slide-out interior gives plenty of working room, requires no screws.



100 amp parallel fuse puller combination, with 60 amp main and range pullers; wired-in branch puller and independent sealable puller are 30 amps each, Catalog Number TC 22119-8. Narrow, shallow box simplifies flush installations.

**GENERAL**  **ELECTRIC**

**look  
beneath  
the braid**

*...that's where  
quality begins*

## felted asbestos walls assure long cable life

N.E.C. Type AVA cables may look alike, but a look under the braid shows how time-proven Rockbestos A.V.C. Type AVA is built to ensure long life.

Each asbestos wall in Rockbestos A.V.C. construction is a dense, homogeneous, "seamless tube" . . . long, silky fibres of asbestos, thoroughly impregnated with selected compounds, make a nonporous,

permanently heat-resistant wall. Heat dissipation is uniform. Dielectric strength is maintained under severe conditions. This seamless construction cushions the cable, protects the varnished cambric from rupture in the sharpest bends.

Write for the test and construction specifications of Rockbestos A.V.C. available in the new booklet: "Specification RSS-88".



**ROCKBESTOS PRODUCTS CORP.**  
**NEW HAVEN 4, CONNECTICUT**

NEW YORK • CLEVELAND • DETROIT • CHICAGO • PITTSBURGH • ST. LOUIS • LOS ANGELES • NEW ORLEANS • OAKLAND, CALIFORNIA • SEATTLE

Left — Heavy, felted asbestos walls are applied over and under the varnished cambric tapes . . . then thoroughly impregnated . . .  
Right — then the impregnated asbestos is compressed to a dense, homogeneous wall that ensures long cable life.

**STOCKED COAST TO COAST**  
Standard Rockbestos A.V.C. construction (N.E.C. types AVA, AVB, etc.) are available for immediate shipment. Call or write nearest branch office.





This exclusive offset connector made by

# Tube-weld

presents a new concept in electric fitting design!

**Bending offset connectors wastes time and money!** Tube-Weld eliminates this costly, time consuming chore with this new concept in design. Developed after careful study of electrical contractor needs — this unique fitting allows fast, economical connecting and wiring. Tube-Weld's one-piece, thin wall steel tubing means increased inside diameters. Its longer length means greater bearing support and rigidity of conduit. You can put your confidence in

Tube-Weld fittings:

- in the oversized hardened steel set screws that are *staked for permanency!*
- in the uniformly flat connector shoulders that assure perfect centering in the box.
- in the rolled instead of cut threads which have 54% greater stripping strength and 66% greater snapping strength according to an independent testing laboratory report.

- in the smooth, lustrous zinc finish and carefully beveled edges—your assurance of workmanship that is unsurpassed in the electric fitting field.

Tube-Weld fittings are available in ½", ¾" and 1" sizes. They are carefully and smartly boxed for ease in shelving and identification. For descriptive brochure and additional information, write or call: **Electric Tube Products**

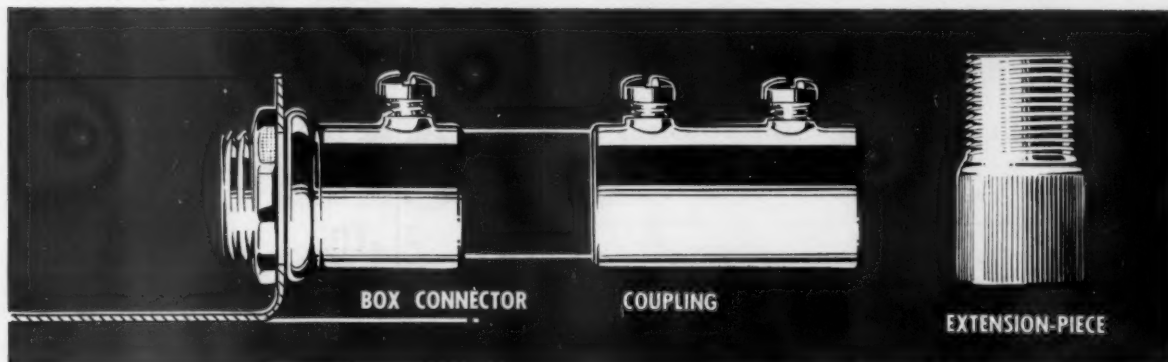
74-16 Grand Ave., Maspeth (N.Y.C.) N.Y.

DEfender 5-8000



CONNECT WITH  FOR ECONOMY

A Division of Berger Machine Products, Inc.



# "Talk-Don't Walk"

## MODERN BUILDING PLANS SPECIFY COMPLETE INTER-COM SYSTEMS

Good inter-com systems are just as accepted as a part of today's architecture as its modern design. Permanently built-in communication systems naturally include the long-life, trouble-free characteristics provided by Belden Inter-Com Cables.

There is a specialized Belden Cable for every inter-com or sound system requirement.

Belden Manufacturing Co.  
4623-A W. Van Buren St.  
Chicago 44, Ill.



For *Permanent* Installations  
For Profitable Work

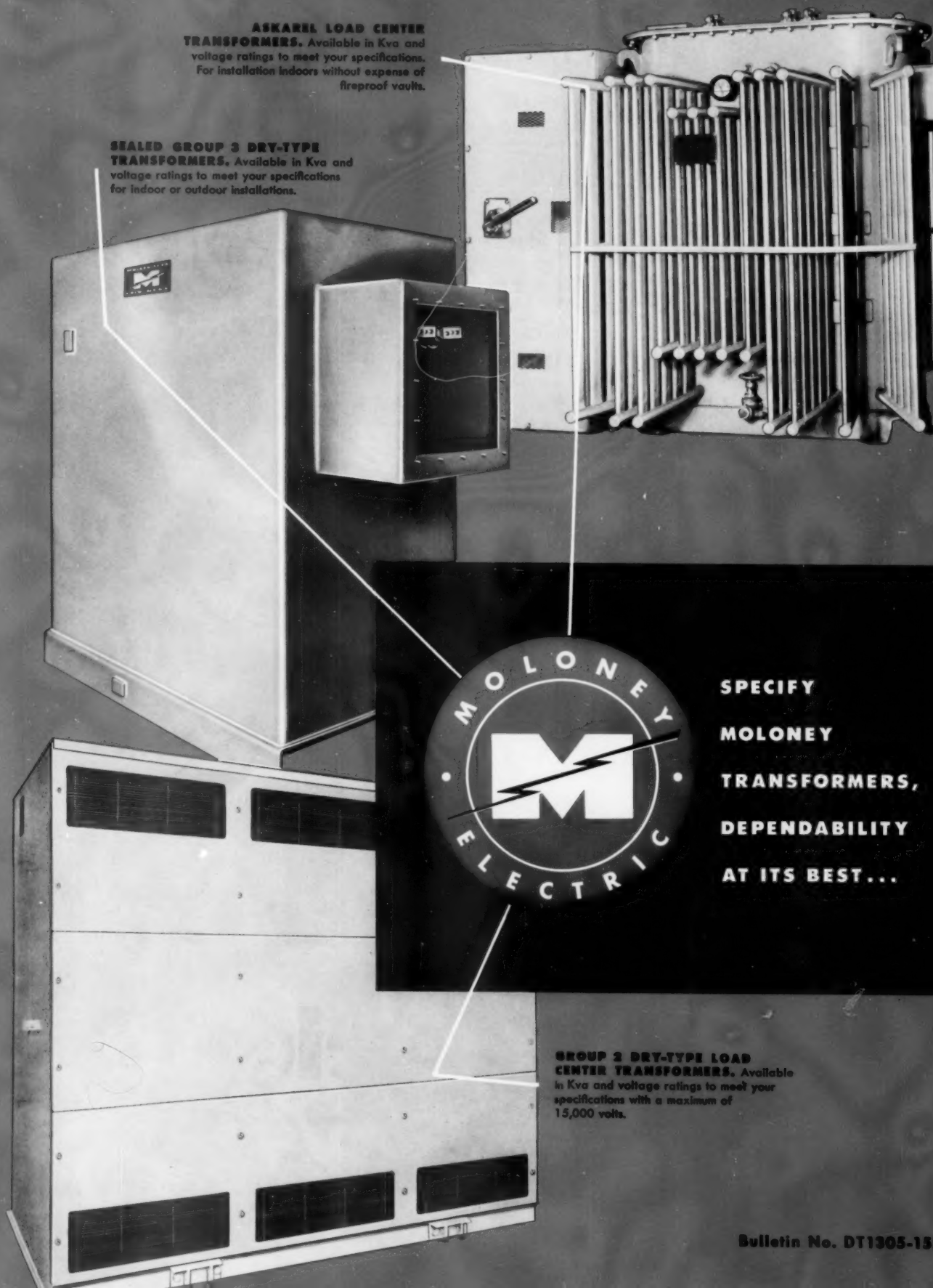
FOR EVERY TYPE OF INSTALLATION  
FOR EVERY TYPE OF EQUIPMENT  
BELDEN HAS THE CABLE BUILT TO  
SPECIFICATIONS

**Belden**  
*Inter-com*  
**CABLE**



**ASKAREL LOAD CENTER TRANSFORMERS.** Available in Kva and voltage ratings to meet your specifications. For installation indoors without expense of fireproof vaults.

**SEALED GROUP 3 DRY-TYPE TRANSFORMERS.** Available in Kva and voltage ratings to meet your specifications for indoor or outdoor installations.



**SPECIFY  
MOLONEY  
TRANSFORMERS,  
DEPENDABILITY  
AT ITS BEST...**

**GROUP 2 DRY-TYPE LOAD CENTER TRANSFORMERS.** Available in Kva and voltage ratings to meet your specifications with a maximum of 15,000 volts.

**HANG YOUR POWER PROBLEMS HIGH AND DRY WITH . . .**



**TYPE DWH DRY-TYPE TRANSFORMERS**

1½ through 15 Kva, 600 volts and below.

KVA	ENCLOSURE	A	B	C	D	WT.
1½	8½" x 11¼" x 14"	17%	12	8%	14%	60 lbs.
3	8½" x 11¼" x 14"	17%	12	8%	14%	80 lbs.
5	10½" x 13¾" x 15¼"	18%	14%	10%	15%	110 lbs.
7½	10½" x 13¾" x 15¼"	18%	14%	10%	15%	125 lbs.
10	13½" x 16¾" x 18¼"	22½	16%	14	18%	175 lbs.
15	13½" x 16¾" x 18¼"	22½	16%	14	18%	250 lbs.

**TYPE DWH DRY-TYPE TRANSFORMERS**

25 through 50 Kva, 600 volts and below.

KVA	ENCLOSURE	A	B	C	WT.
25	19½" x 20½" x 25"	29%	20%	19%	385 lbs.
37½	26" x 20½" x 30"	34%	20%	26%	485 lbs.
50	26" x 20½" x 30"	34%	20%	26%	605 lbs.



**TYPE DVB DRY-TYPE TRANSFORMERS**

25 through 50 Kva, 600 volts and below.

KVA	ENCLOSURE	A	B	C	WT.
25	17¼" x 18¼" x 26"	30%	20%	19%	385 lbs.
37½	19¼" x 18¼" x 26"	30%	20%	21%	470 lbs.
50	19¼" x 18¼" x 26"	30%	20%	21%	590 lbs.



## DRY TYPE TRANSFORMERS

Moloney single phase, Dry Type Transformers are contained in neat, attractively designed machinery gray enclosures which contribute to the overall appearance of any installation.

These transformers incorporate the wound Moloney HiperCore Cores resulting in a more compact, light weight unit.

Mounting arrangements have been designed to permit a flexibility of location with ease of installation.

Large terminal compartments, with knockouts, permit conduit connections from all directions. Accessible solderless connectors facilitate incoming wire connections.

High Voltage Volts	High Voltage Taps	Kva Ratings with a Low Voltage of 120 240 Volts	
		Type DWH	Type DVB
120 x 240	None	1½, 3, 5, 7½, 10, 15, 25, 37½, 50	25, 37½, 50
240 x 480	None	1½, 3, 5, 7½, 10, 15, 25, 37½, 50	25, 37½, 50
	1-10% BN x 2-5% BN	1½, 3, 5, 7½, 10, 15	—
	2-5% BN x 4-2½% BN	25, 37½, 50	25, 37½, 50
480	2-5% BN	1½, 3, 5, 7½, 10, 15, 25, 37½, 50	25, 37½, 50
600	None	1½, 3, 5, 7½, 10, 15, 25, 37½, 50	25, 37½, 50
	2-5%	1½, 3, 5, 7½, 10, 15	25, 37½, 50
	4-2½%	25, 37½, 50	25, 37½, 50



S T . L O U I S , M O .

## HOW TO SPECIFY MOLONEY TRANSFORMERS

When specifying or ordering—

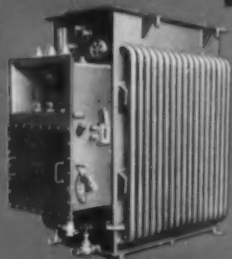
- POWER TRANSFORMERS
- DISTRIBUTION TRANSFORMERS
- LOAD TAP CHANGING TRANSFORMERS
- NETWORK TRANSFORMERS
- REGULATING TRANSFORMERS
- FEEDER VOLTAGE REGULATORS
- UNIT SUBSTATIONS
- LOAD CENTER TRANSFORMERS
- CONSTANT CURRENT TRANSFORMERS
- SUBWAY TRANSFORMERS
- DRY TYPE TRANSFORMERS

The following information should be given, in order

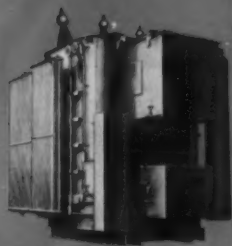
1. Number of units
2. Kva rating of units
3. Type of Cooling
4. Maximum Permissible Temperature Rise °C
5. Phase (Single or Three)
6. Frequency in cycles per second
7. High Voltage rating (primary windings and taps) and insulation level
8. Low Voltage rating (secondary winding and taps) and insulation level
9. Voltage of other windings and taps and insulation level if required
10. Impedance requirements if any
11. Optional features as required
12. Service conditions

# DEPENDABILITY AT ITS BEST . . . ALL ALONG THE LINE

Moloney offers a complete line of quality transformers and regulating equipment from the smallest distribution transformers to the largest power transformers for Utility, Industrial and Electronic applications, second to none in superior performance.



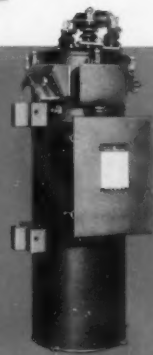
**NETWORK TRANSFORMERS.** Available in either EEL-NEMA standard or special ratings.



**LOAD TAP CHANGING TRANSFORMERS.** Available in any Kva and voltage rating.



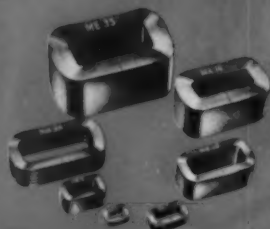
**LARGE DISTRIBUTION TRANSFORMERS.** Available in all standard Kva and voltage ratings.



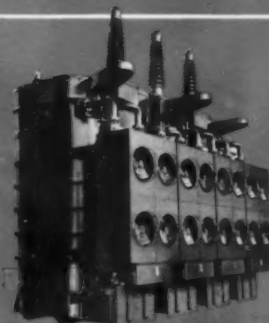
**SINGLE PHASE POLE TYPE FEEDER VOLTAGE REGULATORS.** Plus or minus 10% voltage regulation in 32-1/2% steps.



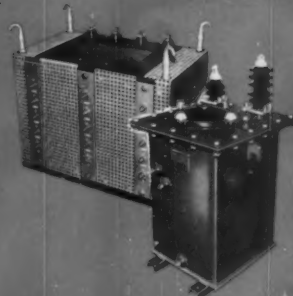
**SINGLE CIRCUIT UNIT SUBSTATIONS.** Complete package units for outdoor installations.



**ELECTRONIC CORES.** HiperCore Wound Cores for smaller, lighter, low-loss electronic transformers.



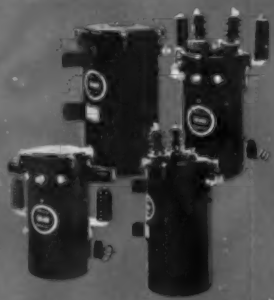
**POWER TRANSFORMERS.** Available in Kva and voltage ratings for any utility or industrial application.



**TRANSFORMERS FOR ELECTRONICS.** Available in all sizes and voltage ratings for Radio, Television, Military and special applications.



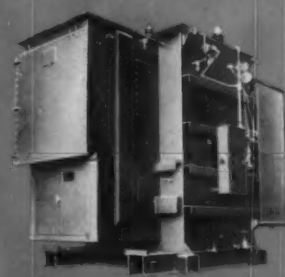
**CONSTANT CURRENT TRANSFORMERS.** Available in standard and special ratings in both Conventional and Packaged Unit Types.



**HIPERCORE CONVENTIONAL AND CSP DISTRIBUTION TRANSFORMERS.** Available in all standard EEL-NEMA ratings.



**SUBWAY TRANSFORMERS.** Submersible and available in all standard and special ratings.



**REGULATING TRANSFORMERS AND FEEDER VOLTAGE REGULATORS.** Available in standard and special Kva and voltage ratings.

Litho in U.S.A.



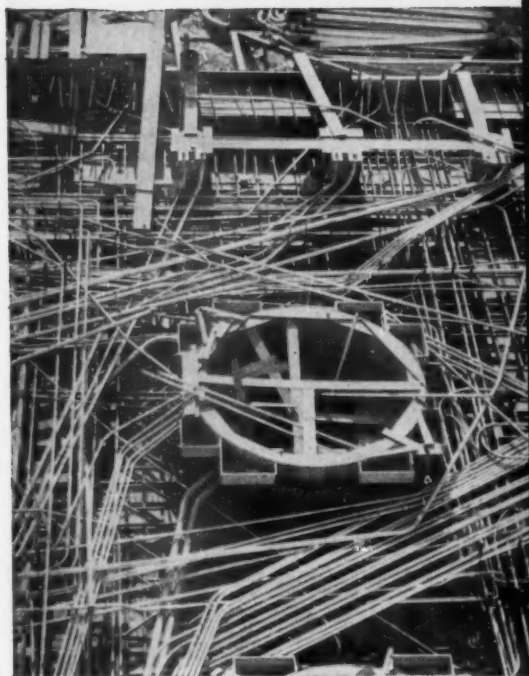
## M O L O N E Y      E L E C T R I C      C O M P A N Y

Power Transformers • Distribution Transformers • Step Voltage Regulators • Regulating Transformers • Load Tap Changing Transformers • Load Center Transformers • Unit Substations • Network Transformers • Constant Current Transformers • Capacitors • Transformers For Electronics

SALES OFFICES IN ALL PRINCIPAL CITIES • FACTORIES AT ST. LOUIS 20, MO. AND TORONTO, ONT., CANADA



# No more on-the-job thread rusting worries



Here's the development which has meant a revolutionary step forward to contractors and plant engineers—Pittsburgh Standard's exclusive new process of galvanizing threads on hot-dip galvanized conduit. Threads stay bright, clean, rust-free!

With no rusting in storage or on the job, and no more expensive thread chasing, hours and dollars are saved. No wonder the men who use hot-dip galvanized conduit are switching to Pittsburgh Standard—here's a bonus from our extraordinary new \*Morrisville plant which dramatically shows why Pittsburgh Standard is the "Standard of the Trade."

Why not try it, and see for yourself?

## *Famous "Standard of the Trade" Products*

**RIGID STEEL CONDUIT**

All Finishes

**ELECTRICAL METALLIC TUBING**

**ELBOWS • COUPLINGS • FITTINGS**

*\*Galvanized threads on all sizes from the Morrisville plant, and on sizes 2-in. and larger from the Etna plant.*

with **EXCLUSIVE**  
**PITTSBURGH STANDARD**  
**GALVANIZED**  
**THREADS**  
**ON HOT-DIP**  
**GALVANIZED CONDUIT**



**61 BRIDGE ST., PITTSBURGH 23, PA.**

PLANTS AT MORRISVILLE & ETNA, PA.

WHOLESALE IN PRINCIPAL CITIES

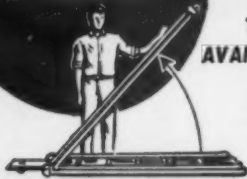


WALTER D. VANCE, JR., Vice President • California Electric Co., reports:

**"We saved 14 days installing  
527 fixtures by using  
'UP-RIGHT' Scaffold-on-Wheels"**

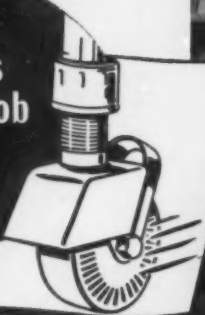
Man-hour savings on this General Motors warehouse job amounted to over 40%. Up-Right Scaffold is so light it is easily assembled by one man. Individual 1 piece aluminum alloy sections are unfolded and set one on top of the other. They lock into place instantly.

**14' tower  
assembled in  
2 minutes**

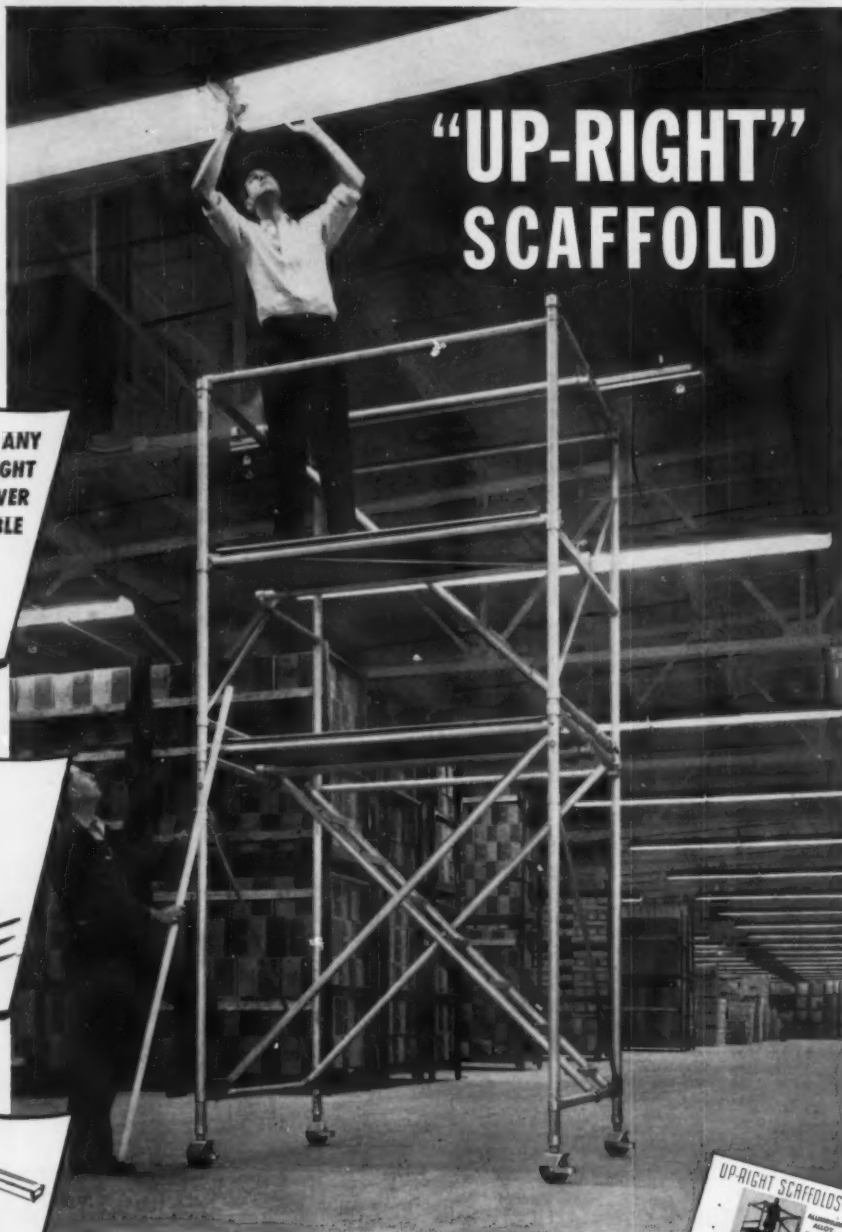
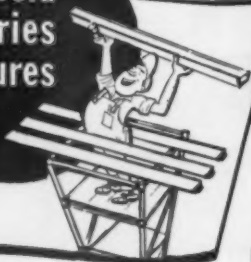


**ANY  
HEIGHT  
TOWER  
AVAILABLE**

**Rolls  
with job**



**Scaffold  
carries  
fixtures**



Write for descriptive circular ➡

**"UP-RIGHT" SCAFFOLDS**

Dept. 159 • 1013 Pardee Street • Berkeley, California

Factories: Berkeley, Calif. and Teterboro, N. J. • Offices in all principal cities



# TOWER OF PROTECTION

**Insulating products  
that meet and  
exceed the standards  
of industry . . .**

## Dutch Brand

### **DUTCH BRAND PLASTIC ELECTRICAL TAPES**

Thin, strong, flexible with unusual resistance to destructive elements. Three thicknesses: .007", .010", .020".

### **DUTCH BRAND VINYL COLOR TAPE**

Nine colors, four widths for all insulating, coding, indexing, U. L. listed.

### **DUTCH BRAND RUBBER TAPE**

The finest tape of its kind. Resists up to 18,000 volts through a single thickness. Fuses perfectly.

### **DUTCH BRAND FRICTION TAPE**

An industry favorite for over 40 years. For perfect adhesion, for longest life choose Dutch Brand.

### **"DB" WIRE CONNECTORS**

Get full insulation protection from these vibration-proof, weatherproof long skirt connectors.

**Write for descriptive literature  
and technical data.**

Whatever the requirements of the job here is the product to meet the specifications. Wherever electrical work is done, the symbol of perfect insulation is the Dutch Brand trade mark. Electrical contractors, plant maintenance electricians, electronic technicians, and electrical manufacturers all agree Dutch Brand represents the finest. Friction Tape, Rubber Tape, Plastic Electrical Tape and "D.B." Wire Connectors. Only from Dutch Brand is this complete line available.



**Johns-Manville  
DUTCH BRAND  
PRODUCTS**

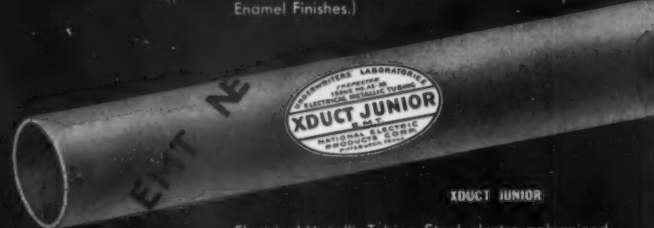
VAN CLEEF BROS., INC. DIVISION  
7800 WOODLAWN AVENUE CHICAGO 14, ILL.

## Conduit Systems



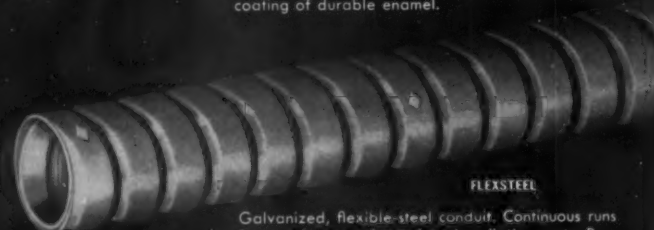
SHERARDUCT

Full weight, threaded, rigid steel conduit fortified against rust and corrosion by the "Sherardizing" process of galvanizing, for lifetime protection. (also Xduct Electro-Galvanized and Economy Black Enamel Finishes.)



XDUCT JUNIOR

Electrical Metallic Tubing. Steel, electro-galvanized, then further protected inside by a smooth, lustrous coating of durable enamel.



FLEXSTEEL

Galvanized, flexible-steel conduit. Continuous runs from outlet to outlet reduce installation costs. Provides an economical "pull-in pull-out" electrical system.

## Busway Systems



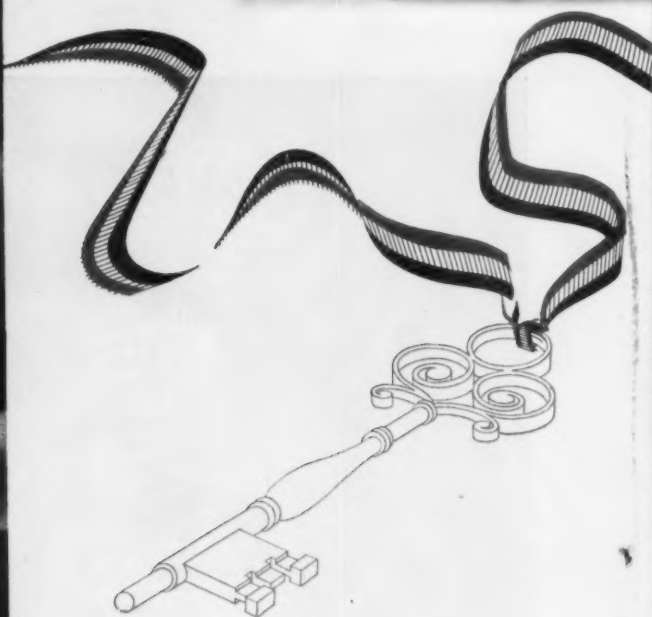
L.P.I. "PLUG-IN" BUSWAY

An enclosed busbar system for distributing electrical power, 225 amperes up to 1500 amperes, 600 volts or less. Approved for mounting in horizontal or vertical position. 14 Plug-in openings per 10' length, staggered on two sides, permit insertion of devices convenient to equipment.



L.O. LOSS FEEDER BUSWAY

Designed for transmission of electric current up to 4000 amperes at 600 volts or less. Insulated copper bars mounted on close centers provide low reactance—high efficiency. Ideal for welding and other low power factor loads and for riser application. Approved for vertical or horizontal mounting.



# National Electric holds the key to better Electrical Systems

National Electric holds the key to efficient electric distribution for new construction or modernization of industrial, commercial, residential or institutional buildings. That's because each National Electric distribution system is especially designed to meet certain specific wiring needs and to withstand the rugged requirements of American industry.

National Electric Products stands for highest quality, a name immediately recognized as a leader in the electric industry for nearly 50 years. It is this leadership that has made National Electric the world's *largest* manufacturer of electrical distribution systems today.

Your electrical distribution system is the lifeline of your business. Select it with care. Look them all over. Study their features and the "added extras." Compare them for quality, for convenience, for economy, for flexibility, for salvability. Whatever your electric distribution problem, we think you'll agree—it's *National Electric all the way.*

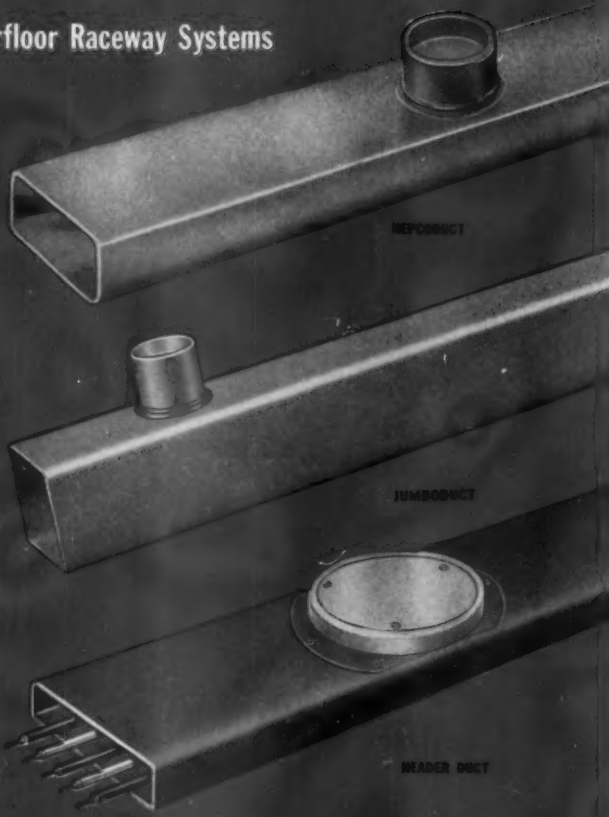
**National Electric Products**  
PITTSBURGH, PA.

3 Plants • 10 Warehouse • 36 Sales Offices

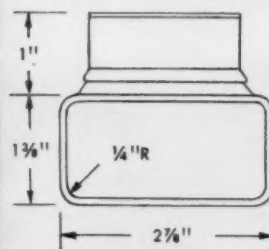




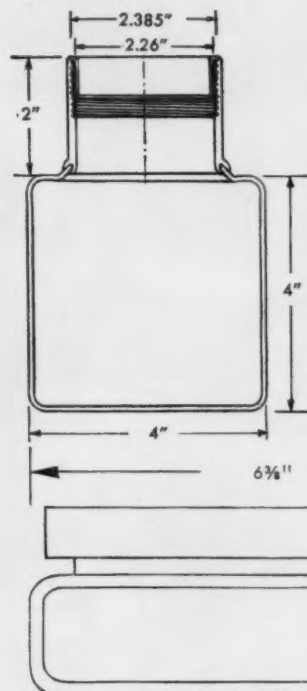
## Underfloor Raceway Systems



## Surface Raceway Systems

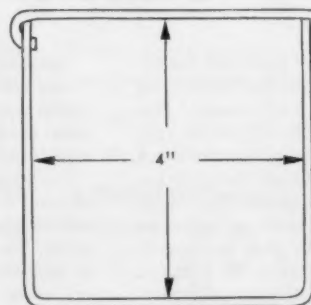


The steel underfloor raceway system that provides convenience outlets at the floor surface. For power, lighting, telephone and signal service in any type of floor construction. Safe, attractive service fittings.

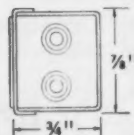


The new Jumboduct Industrial Underfloor Wiring System is a steel raceway of 4" width and depth. Suitable Junction Boxes, Assembly Parts and Service Fittings complete the System. Brings outlets already threaded to the floor surface for quick, efficient power service to machines located anywhere in the plant.

Used in conjunction with Cellular Steel Floor Panels, Nepco Header Duct System is an all-steel grounded raceway from the distribution outlet to the structural steel floor panels. Electric wiring through this combined raceway system provides the availability of electric outlets in any square foot of floor area—a completely electrified cellular steel floor.



A hinged-lid steel wireway for feeders, branch circuits, control and signal wiring up to 600 volts. Speeds power rewiring. Eliminates exposed wiring hazards. Hanger type coupling permits flush mounting when necessary. Painted gray for color harmony. Galvanized Wirem also available for maximum corrosion resistance in coastal areas.



Multi-outlet wiring assemblies that provide outlets every 18" or 6". Modern, streamlined trim. Safe and strong. Type CF2-G (with system grounding facility) for portable equipment, tools, etc. Grounded or ungrounded devices from same outlet.



A 2-piece, all-purpose industrial "lay-in" raceway for every type of service up to 60 amp. No wire fishing. Accommodates all manufacturers' approved devices. Economical to install for today's wiring needs yet has plenty of capacity for tomorrow's requirements.



## Custom Lighting with **LITECONTROL** *Increased Production Here*

Ceiling and walls are light and the fixtures' sides seem almost luminous in this custom lighting job with standard *Litecontrol* fixtures. Almost 40% of its light is thrown upward by *LITECONTROL* 2428, the fixture used here. Perimeter fixtures illuminate walls evenly. The results: plenty of light for work, and freedom from strain wherever eyes may travel.

Here's how Mr. Frank H. Rimmer, President of Relief Printing Corporation, described the results: "Our records already show that our investment into this modern, standard lighting installation has increased the efficiency of employees in all departments. There have been less errors made in printing, and there has been a most encouraging increase in factory and administrative production."

Installation and maintenance of *LITECONTROL* 2428 is fast and simple because of its rugged, two-piece, all-metal construction. Curved surfaces are easy to wipe clean. Efficiency is 86%.

For every lighting job, it pays to use efficient, versatile *Litecontrol* fixtures... custom lighting at standard fixture prices. Basic fixtures can be combined or modified to meet every need. Call or write your local *LITECONTROL* representative.

INSTALLATION: Relief Printing Corp., Boston, Massachusetts

ENGINEER: C. A. Russell, Boston Edison Co.

ELEC. CONTRACTOR: George Phelps Co.

TYPE OF AREA: Packaging and Mailing

FINISHES: Ceiling, pastel yellow  
Walls, light green

CEILING HEIGHT: 14'-0"

FIXTURES: *Litecontrol* No. 2428 Slimline Industrial Fixture, Pendant Mounted

MOUNTING HEIGHT: 12'-0"

SPACING: 11'-0" on centers  
Perimeter row of fixtures: 3'-6" from wall

INTENSITY: 60 footcandles average initially

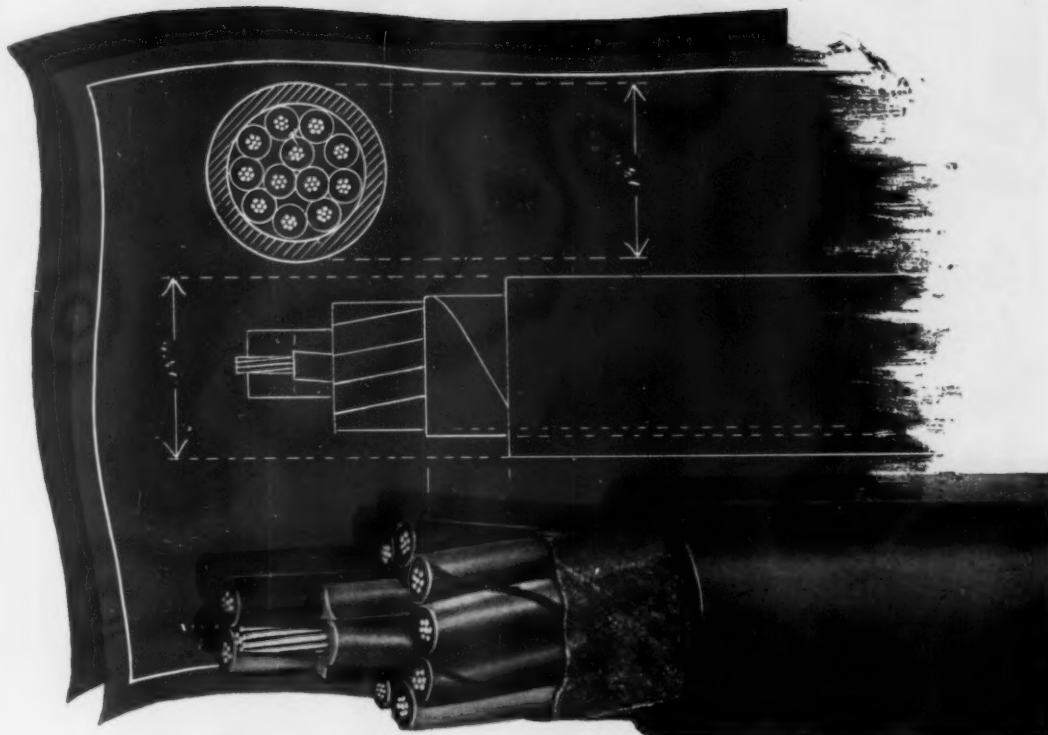


# **LITECONTROL** *Fixtures*

KEEP UPKEEP DOWN

LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALEERS



**WATERTITE-HAZAPRENE CONTROL CABLE**

## DESIGN DOESN'T COST... IT PAYS

Good design is just about all that matters in control cables. If you start with good design it will pay off in dependability, long service life and economy.

Watertite-Hazaprene control cables are designed with the following features:

**SHEATH:** Tire-tough Hazaprene ZBF: neoprene compounded to Hazard's exclusive formula. Offers superior resistance to flame, oil, acid, moisture, sunlight and mechanical damage. Pressure-vulcanized in a continuous metal mold for a smooth, dense surface that resists abrasion and tearing.

**INSULATION:** Long-lived Watertite, a firm, elec-

trically stable, rubber insulation that resists moisture and heat, prevents deformation.

**FILLERS:** Rubber, to prevent the wicking-in of moisture and to add firmness to the construction.

**CONDUCTORS:** Strong and flexible; tin coated to resist corrosion.

There's a Watertite-Hazaprene cable for every control circuit requirement. See your Hazard representative or write for complete information. Hazard Insulated Wire Works, Division of The Okonite Company, Wilkes-Barre, Pennsylvania.



**HAZARD**  **insulated cables**

1450

Complaint  
headaches?

Call-back  
blues?



Service call  
hangover?

## INSTALL SANGAMO TIME SWITCHES!

If you're like most busy contractors these days, you just haven't got time to make service calls on time switch installations. Besides, call backs are a nuisance and they cost you money.

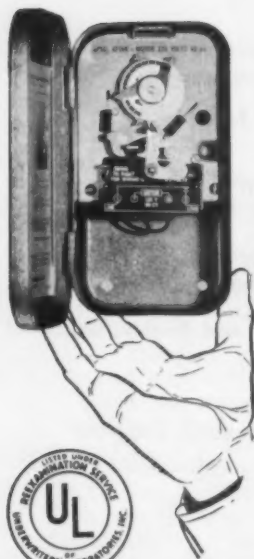
*That's why we recommend the...*

### **SANGAMO HEAVY DUTY TIME SWITCH**

For installations that require more than a single-pole, single-throw switch, the Sangamo Heavy Duty Time Switch is your answer.

The Heavy Duty is available with an *Automatic Carryover* which assures continued operation for up to 10 hours in the event of a power failure... an *Omitting Device* which can be set to omit operations for one or more 24-hour periods.

Or, you can order the Heavy Duty with an *Astronomic Dial* which automatically controls the switching schedule in accordance with sunrise and sunset.



*... don't forget the*

### **SANGAMO TYPE B TIME SWITCH**

Here's a low-priced yet rugged single-pole, single-throw time switch that also will end your service call headaches. It's designed for quick, easy installation.



Your electrical wholesaler can furnish you with all types of dependable Sangamo Time Switches. Insist on Sangamo—for the best in time switch performance.

ST35-2

## **SANGAMO ELECTRIC COMPANY**

SPRINGFIELD, ILLINOIS





### **This man won't be back...**

The specifications read: PERMANENT GROUNDING. They used CADWELD Electrical Connections knowing that they are permanent, cannot loosen or corrode and have a greater current carrying capacity than the cable itself.

No maintenance is ever required on a CADWELD Electrical Connection.

## **CADWELD®**

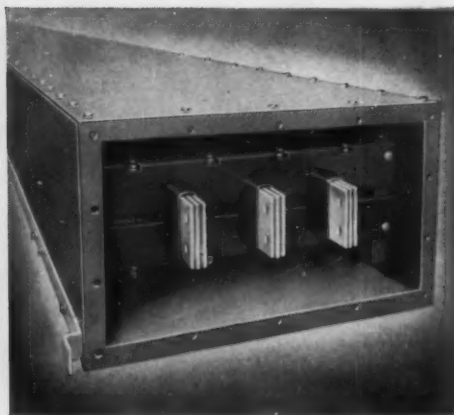
**Erico Products, Inc.**

2070 E. 61st Place • Cleveland 3, Ohio

IN CANADA: ERICO INCORPORATED, 3571 Dundas St., West, Toronto 9, Ontario



**Metal-clad switchgear.** Horizontal drawout air circuit breakers in rigid, all-welded enclosures. Available in ratings from 2400 v through 15 kv—50 through 500 mva interrupting and 2000 amp continuous.



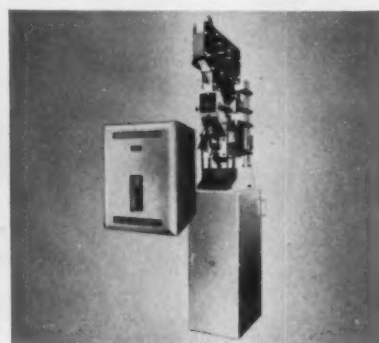
**Nonsegregated phase, metal-enclosed bus.** For switchgear connections. In ratings 600 v through 6000 amp; 5, 7.5 or 15 kv through 5000 amp.



**Unit substations.** I-T-E primary and secondary unit substations can be supplied for any application—indoor and outdoor—and in any standard rating.



**Low voltage switchgear.** Ratings through 600 v a-c, 250 v d-c, 6000 amp continuous, 15,000 through 150,000 amp interrupting.



**Individual breakers.** I-T-E large air circuit breakers are available in a wide range of types and ratings, 600 v a-c, 250 v d-c, 750 v d-c.

## NEW CONSTRUCTION ECONOMY TIP: BUY AN I-T-E "POWER PACKAGE"

**Coordinated engineering, delivery and installation means a better investment**

An I-T-E "power package" includes the complete power handling facilities you need for a new construction project, building addition, or simple expansion of electrical service—one unit or a complete system for application from generation to end use. You save many days:

**Sound planning.** Talk with your local I-T-E application engineer about your general power requirements before you build. He'll work with you to determine the equipment needed to assure complete protection with greatest economy in total investment, operating costs, and construction time.

**Easier installation.** Before you begin construction, I-T-E will supply you with

arrangement and channel base drawings. Equipment is factory assembled, tested and ready to install. Standardized frames and panel elements assure that future additions to your switchboard will match and line up.

**Coordinated delivery.** Shipments are made from I-T-E according to a predetermined schedule. Each part of the complete "power package" is delivered to the job when needed. This saves delays and eliminates inconveniences.

**Assured performance.** Since I-T-E will supply all equipment—pre-engineered—you are saved the work of coordinating equipment of different manufacture. You can be sure that the separate parts of an I-T-E "power package" will fit and function together.

For details, contact the I-T-E sales office nearest you—look in your classified directory under "Electric Equipment." I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.



**I-T-E CIRCUIT BREAKER COMPANY**  
Switchgear Division

# A STATEMENT OF POLICY

on our backing-up of

## **Authorized**

### **GENERAL CABLE DISTRIBUTORS**



**with a  
coast-to-coast  
network  
of stocks  
in bulk  
supply**

To take giant steps, to set the pace . . . this is the responsibility of leadership. It sums up the history and current business philosophy of the General Cable Corporation. For example:

It is our policy, through a nationwide network of distributing centers, to place at the disposal of our family of Authorized Distributors additional, close-at-hand supplies of the fastest moving items they sell in our line . . . the largest offered by any electrical wire and cable manufacturer in the industry.

It is our policy to offer this "supporting" service to

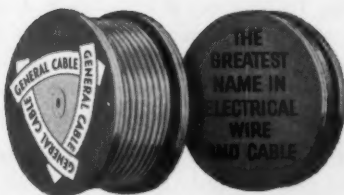
Authorized Distributors only.

It is our belief that this expanding service will enable our Authorized Distributors to better serve their customers with faster deliveries . . . easier and more efficient handling of seasonal needs . . . and to help them give their customers the exact type of electrical wire and cable they need when they need it.

We invite every member of our family of Authorized Distributors to use our service to back up his own sales programs. Ask any General Cable Representative for complete details.



***THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE***

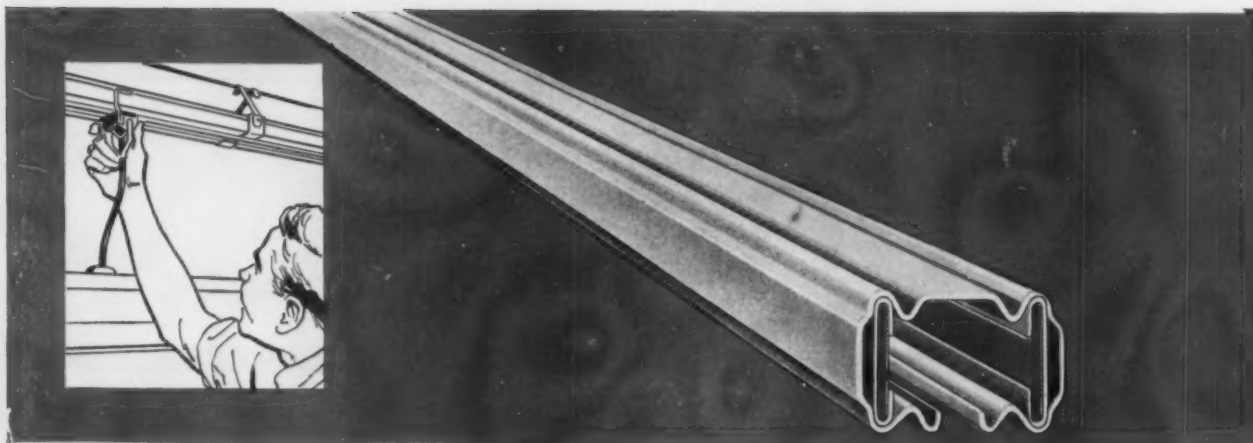


**SAFE, WEATHERPROOF, INSULATED WIRES and  
CABLES FOR EVERY ELECTRICAL PURPOSE**

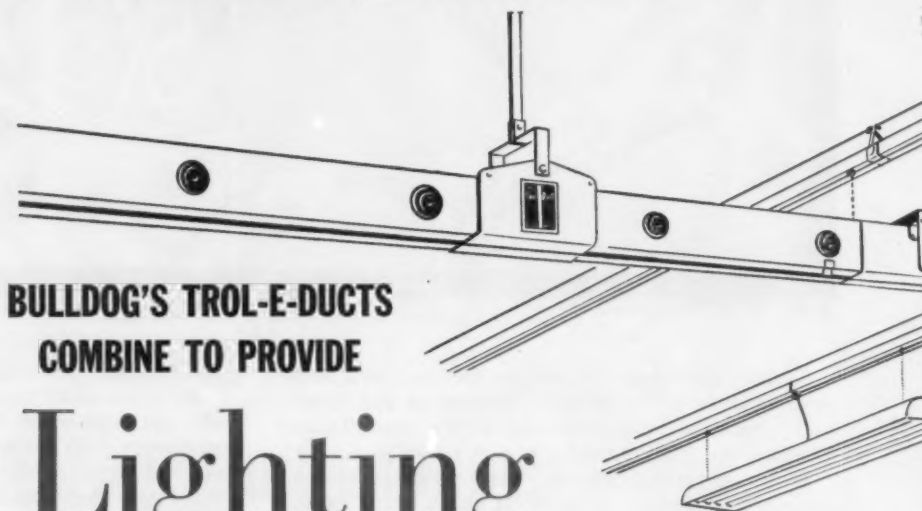
#### **GENERAL CABLE CORPORATION**

*Executive Offices: 420 Lexington Ave., New York 17, N. Y.*

**SALES OFFICES:** Atlanta • Baltimore • Boston • Buffalo  
Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit  
Erie (Pa.) • Greensboro (N. C.) • Houston • Indianapolis  
Kansas City • Lincoln (Neb.) • Los Angeles • Memphis  
Milwaukee • Minneapolis • New Haven • Newark (N. J.)  
New York • Philadelphia • Pittsburgh • Portland (Ore.)  
Richmond (Va.) • Rochester (N. Y.) • Rome (N. Y.)  
St. Louis • San Francisco • Seattle • Springfield (Ill.)  
Syracuse • Tampa • Tulsa • Washington, D. C.



**UNIVERSAL TROL-E-DUCT FOR LIGHTS AND LIGHT-DUTY POWER TOOLS.** Universal Trol-E-Duct both feeds and supports lights—lets you position them when and where you want them. You can arrange, change, add or remove lights as desired without rewiring, power shut-off or downtime. Twistout plugs (illustrated) give positive, safe connections in seconds. Moving trolleys are also available to bring mobility to light-duty, portable tools.



**BULLDOG'S TROL-E-DUCTS  
COMBINE TO PROVIDE**

# Flexible Lighting Flexible Power!

**EASY TO INSTALL! SAFE, ADAPTABLE, CONVENIENT!**

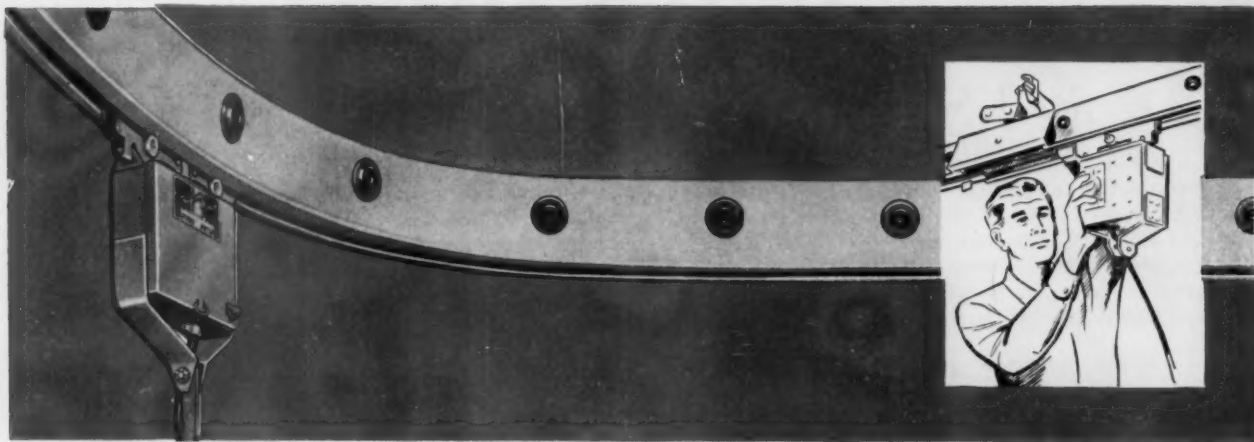
Modern machines and methods require a flexible lighting and power supply. BullDog's Trol-E-Ducts® bring this flexibility to your clients. For Trol-E-Duct is the original bus-bar system that provides a *continuous outlet* everywhere along its length. Lighting and power go *where* they are needed—*when* they are needed. No need, now, to be restricted by fixed outlets. No long extension cords. No downtime or power shut-off when plant layout is changed, or lights and tools are shifted.

BullDog Trol-E-Duct is completely adaptable. It performs with maximum efficiency today, yet lends itself readily and economically to future demands. The duct sections are 100% reusable—can be disassembled and relocated with minimum expense and trouble.

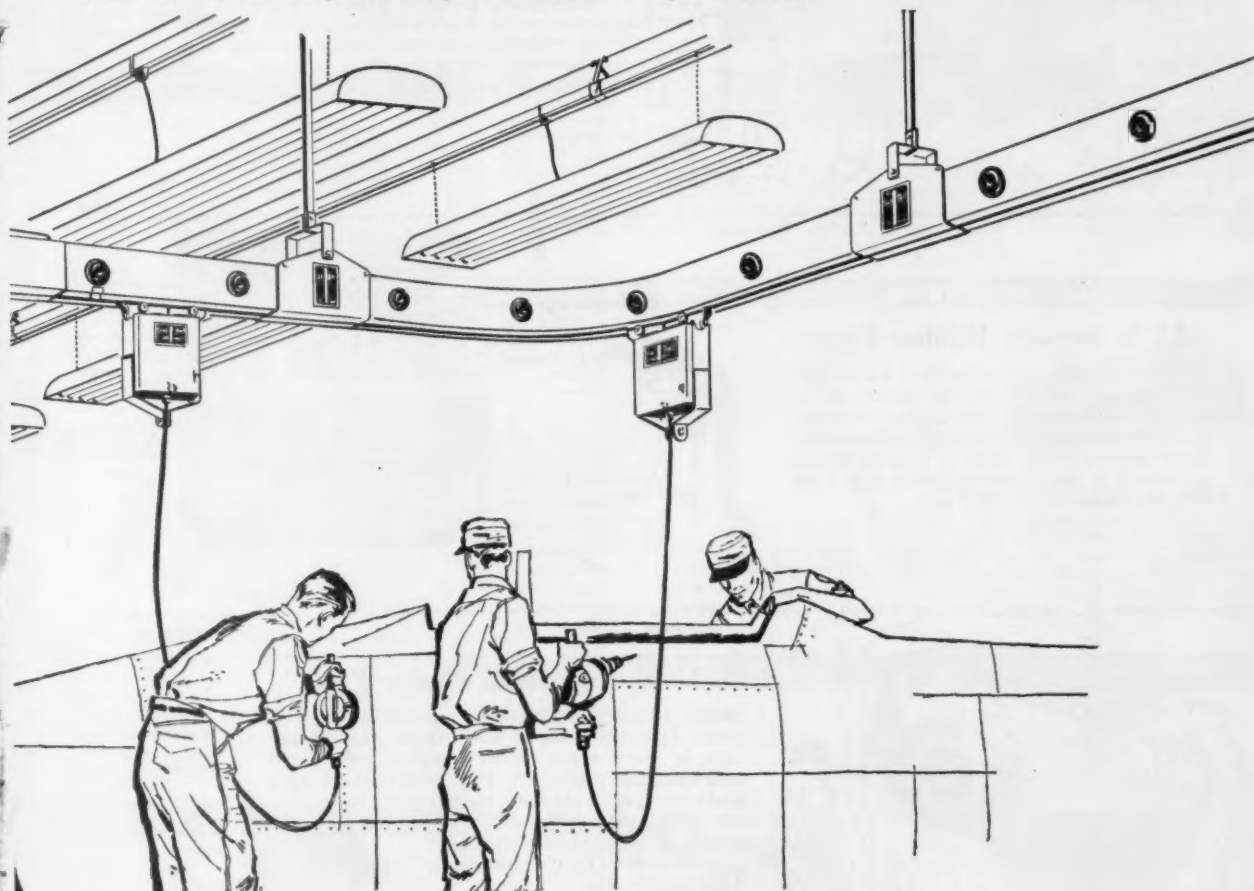
Combine and install these most modern of all lighting and power-supply systems. Consult your BullDog field engineer or qualified distributor. Or, write: BullDog Electric Products Co., Detroit 32, Michigan.

© BEPCO





**INDUSTRIAL TROL-E-DUCT FOR HEAVY-DUTY POWER TOOLS, CRANES AND HOISTS.** Industrial Trol-E-Duct literally provides power on wheels. It's a continuous outlet that feeds current through trolleys right to tools—without long extension cords, without interfering with production. Rugged and strong, it supports moving trolleys (illustrated) that are always where they are needed, when they are needed.



IF IT'S NEW  
... IF IT'S DIFFERENT  
... IF IT'S BETTER ... IT'S



**BULLDOG**

**ELECTRIC PRODUCTS COMPANY**  
A Division of I-T-E Circuit Breaker Company

Export Division: 13 East 40th Street, New York 16, New York. In Canada: Bulldog Electric Products Company (Canada), Ltd., 80 Clayson Road, Toronto 15, Ontario.

# Keep cables in top form with United States Rubber Company's Tapes

Reinsulating and splicing with U. S. Tapes restore a cable or wire to its original dielectric strength and efficiency. They are made by United States Rubber Company, the only tape manufacturer to grow its own natural rubber and make its own synthetic rubber and plastics. "U. S." has amassed

years of experience, research data and skill in the manufacture of tapes that guarantee *dependability* in any one of the tapes in the "U. S." Line.

Because the "U. S." Line is complete, you can simplify purchasing by ordering from this *single* line. Order from a selected "U. S." distributor or any of the 27 "U. S." District Sales Offices.

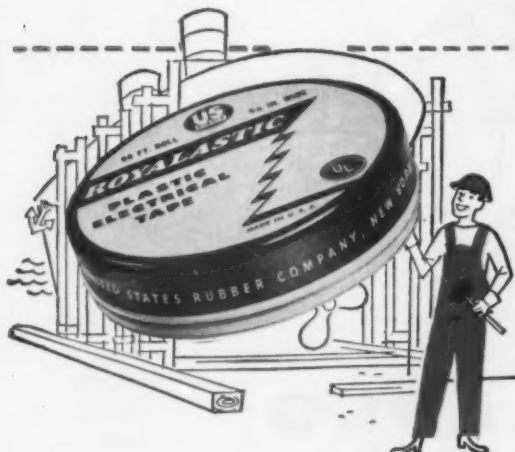
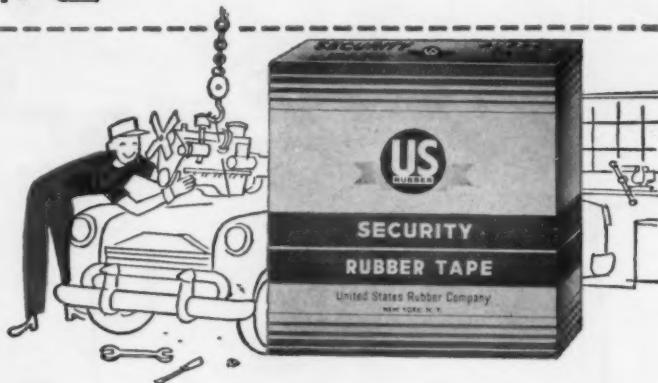


## U. S. Security® Friction Tape

For electrical and general purpose jobs. Strong and tacky—it stays on. Does not age or dry out. Unusually high tensile strength for tough assignments. Straight-tearing, non-ravelling. Also in specification grade — U. S. Holdtite®—exceeds A.S.T.M. specifications.

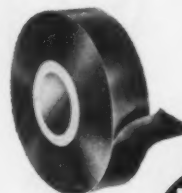
## U. S. Security Rubber Tape

Excellent for all general electrical work. This unvulcanized rubber splicing compound is high in tensile strength, elongation, tackiness, dielectric strength and stretch. Handles easily, fuses without heat. Also in a specification grade—U. S. Holdtite—exceeds A.S.T.M. specifications.



## U. S. Royalastic Plastic Tape

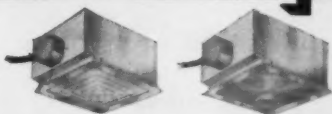
Makes a thin splice, keeps wiring neat and uncluttered. Does the work of both rubber and friction tape in many applications. Complete mechanical and electrical protection. High dielectric strength and resistance to abrasion, water, oils, acids, alkalis and corrosive chemicals. Good stretch, tight grip. Approved by Underwriters' Laboratories, Inc.



**UNITED STATES RUBBER COMPANY**  
MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

# Guth

## the complete line of fluorescents and incandescents



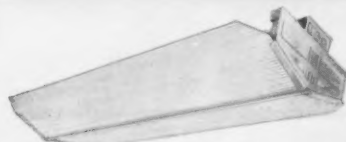
**"ALL-SQUARE"** ...for recessing. One-piece die-cast frame. Light-leakproof. Widespread or concentrating lens...sizes 6½" sq., 8" sq. & 12" sq. PRE-WIRED. Removable top, and drop hinge bottom for servicing from above or below. Catalog 49.

### ▲ "ALL-SQUARE"

**SEELUX** ...totally indirect open bottom Luminaire for Silver Bowl Lamps, with modern ALZAK concentric louvers; for stem suspension or close mounting. Bulletin 864.



### ▲ SEELUX®



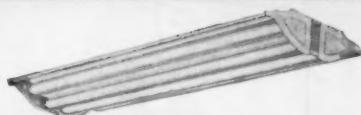
**ARISTOLITE** ...hinged glass panels swing open for easy cleaning from floor with handy servicing tool. Also with center Eggcrate louvers. For 2, 3 or 4 40-watt or 2 or 4 4-ft. SLIMLINE lamps; ceiling or suspension, unit or continuous mounting. Write for Bulletins 812 and 820.

### ▲ ARISTOLITE®



**PEERLITE** ...the new, ultra-modern fixture offering great flexibility. Forms any pattern—T, H, □, +, I. 20% uplight. Top plates available for 100% downlight. For 2, 3 or 4 lamps—4' or 8' long. Supplied with any type of louver or glass diffuser you wish. (Shown with new GrateLite\*\* Louver-Diffuser.) Bulletin 911.

### ▲ PEERLITE \*



**TRUCOLITE** ...versatile, highly efficient, semi-direct type; can be used open, with Eggcrate louvers or diffusing glass bottom. For 2, 3 and 4 40-watt lamps...also 2 and 4 4-ft. or 8-ft. SLIMLINE lamps. Ceiling or suspension, unit or continuous mounting. Bulletins 814 and 852.

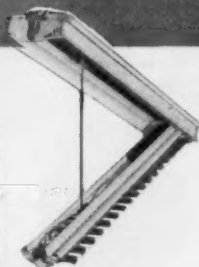
### ▲ TRUCOLITE®

When you specify GUTH Luminaires, you get the benefit of more than a half-century's experience in pioneering better lighting. We make good specialized equipment for every lighting need...all precision-planned for economical installation and maintenance!

**FLUORESCENT:** Commercial and Industrial; Glass diffused, Eggcrate shielded, totally indirect, luminous indirect, recessed troffers and exposed lamp types.

**INCANDESCENT:** Commercial and Industrial; indirect, direct and semi-indirect types; also high bay reflectors, exit and utility lighting units.

**GUTHLITE** ...the revolutionary "Jackknife" Hinge Luminaire that swings down for easy relamping or cleaning right from the floor! For 2 40- or 2 85-watt or 2 4-ft. SLIMLINE lamps; ceiling or suspension, unit or continuous mounting. Simplest fixture to install. Bulletin 845.



### ▲ GUTHLITE®



**WYTE-LINER**...white inside and outside, 7% Uplite component (takes gloom off ceiling). AIRFLOW channel for longer ballast life. Reflectors 300° Permalux or Porcelain Enamel. Made in 2 and 3 40-watt, 2 85-watt, and 4- and 8-ft. SLIMLINE lamps. Easy to install and clean. Catalog 48.

### ▲ WYTE-LINER



**"V" CORRIDOR UNIT**...with GrateLite\*\* Louver-Diffuser. Fills wide hallways and corridors with practical, wall-to-wall light. Lamps shielded by easily maintained GrateLite. Models: 4' & 8' for 1 or 2 lamps. Bulletin 906.

### ▲ "V" CORRIDOR UNIT



**"LITE-BLOX" RECESSED TROFFERS** ...for 1, 2, 3 or 4 lamps: 20-, 40-, 85-watt, or 4-ft., 6-ft., or 8-ft. SLIMLINE. Exclusive end KO's provide exact 48.0"; modular design for unlimited patterns. Wide variety of shielding and diffusing glass panels available; also ALZAK Paralector Louver. Catalog 50.

### ▲ "LITE-BLOX" RECESSED TROFFERS

**GUTH 4-FT. SLIMLINE** available in every GUTH fluorescent fixture

- no starters or starter troubles!
- easy to handle Single-Pin lamps!
- light in two steps almost instantly!



\* Trademark  
\*\*U.S. & Can. Pats. Pend.  
Trademark Registered

THE EDWIN F. GUTH CO. / ST. LOUIS 3, MO.

# O.Z. ELECTRICAL MANUFACTURING CO.

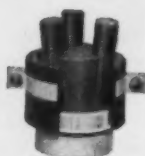
262 BOND STREET, BROOKLYN 17, N. Y.

Representatives in all Principal Cities

**They're O.K. if They're O.Z.**  
 CONDUIT FITTINGS • CABLE TERMINATORS  
 CAST IRON BOXES • POWER CONNECTORS  
 SOLDERLESS CONNECTORS  
 GROUNDING DEVICES



CABLE SUPPORTS  
CONDUIT TYPE



CABLE SUPPORTS  
SPLIT TYPE

## CONDUIT FITTINGS



INSULATED  
BUSHINGS



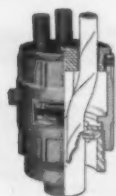
BAKELITE  
BUSHINGS



SPLIT  
COUPLINGS

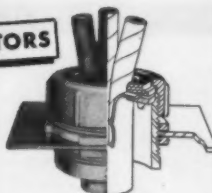


EXPANSION  
FITTINGS



TERMINATING  
POTHEADS

## CABLE TERMINATORS



SEALING  
BUSHINGS



COMBINATION  
LUGS



COMBINATION  
TWO-WAY  
CONNECTORS

## SOLDERLESS CONNECTORS



EXPLOSION PROOF  
TYPE

## CAST IRON BOXES



WEATHER PROOF  
TYPE



COMBINATION  
TEE AND  
PARALLEL CONNECTORS



SERVICE TAP

## POWER CONNECTORS



T-CONNECTORS, TUBE  
TO MULTIPLE CABLE TYPE



BUS BAR  
CLAMPS

## GROUND CONNECTORS





Whatever the **LIGHTING PROBLEM** in front of you...  
thousands of **BENJAMIN** Quality Lighting Systems  
 assure you of a  
**Superior Solution**



Superior Solutions to lighting problems require the *precisely right lighting system* for the seeing task and environment, plus *quality lighting units* built to deliver this lighting at lowest-per-year cost. With Benjamin you get both.

You get the *precisely right lighting system*, because Benjamin's line is so complete that thousands of different lighting systems can be created from it. You get lowest-per-year cost, because every Benjamin Unit has the quality and durability which 50 years of experience has proved to be essential.

Get a Superior Solution to your lighting problem! Start now by sending for **FREE** data bulletins on Benjamin Units for specific plant locations. Address:

**Benjamin Electric Mfg. Co.**  
 Dept. H, Des Plaines, Ill.

1. "Explosion-Proof" Units
2. "Vapor-Tight" Incandescent
3. "Magna-Flo" Continuous Lines
4. "Lite-Line 40" Rows of Light
5. "Magna-Flo" w/27" Lamp Shielding
6. "RLM Dome" Reflectors
7. "Magna-Flo" w/Plastic Covers
8. "Elliptical Angle" Reflectors
9. "Steelite" Armor-Clad Units
10. "Magna-Flo" Individual Units
11. "Symmetrical Angle" Units
12. VOUL Units w/25% Uplight
13. All-white "Diffuser" Reflectors
14. "Sky-Glo" Translucent Ceilings
15. "Stock-Bin-Lite"
16. "Officer" Louvered Units
17. "Panel-Glo" Plastic Ceilings
18. "Varsity" Low-Cost Fluorescent
19. "RD" Projectors
20. "Vapolets" Vapor-Tight Units
21. "Duo-Service" Floodlights

*These and many other Benjamin Lighting Units form the basis for thousands of different industrial lighting systems.*

**BENJAMIN** TRADE MARK

AND *Leader Line*  
**LIGHTING EQUIPMENT**

Sold Exclusively through Electrical Distributors

three tapes — one quality  
**GOLD SEAL**  
 more good jobs per roll



**IN PLASTIC TAPE**

Gold Seal quality gives you high dielectric with a neat, thin wrapping. Sticks fast — resists effects of sunlight, water, oil, solvents. Try it — sample free.

**Guaranteed footage • no waste**  
**lasting "tack" • stays fresh.**  
**Best buy for plant supply.**

**JENKINS**

*Gold Seal Tape*

All types packed in single rolls and 10-roll cartons. Every roll cellophane-protected, stays fresh. Jenkins Bros. (Rubber Division) 100 Park Ave., New York 17.

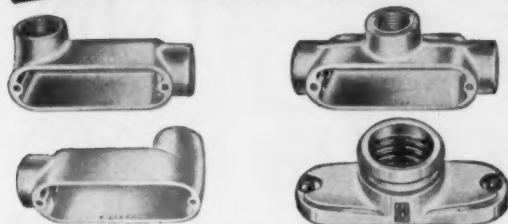


**FRICION • RUBBER • PLASTIC**  
 also Diamond Seal Friction and Rubber Tape  
 made to ASTM Specifications.

**SPECIFY**

**Killark**  
THE ALL-ALUMINUM LINE

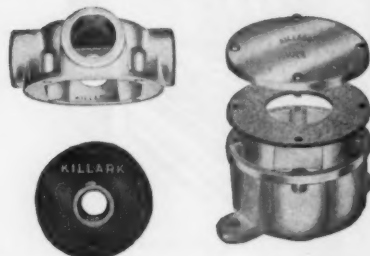
CONDUIT BODIES AND COVERS



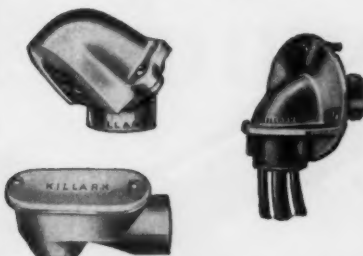
EXPLOSION-PROOF FITTINGS AND SWITCHES



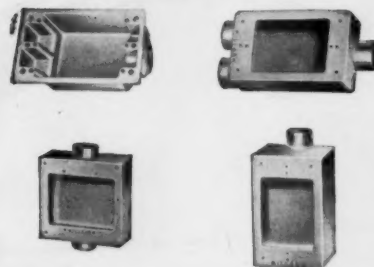
ROUND FITTINGS AND COVERS



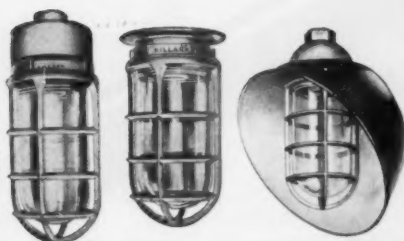
SERVICE ENTRANCE FITTINGS



FLUSH SWITCH FITTINGS



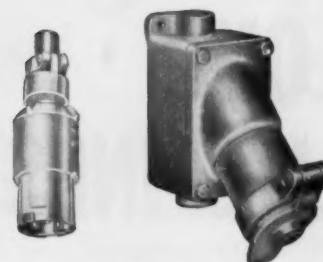
VAPOR-TIGHT LIGHT FIXTURES



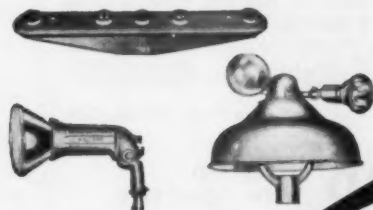
EXPLOSION-PROOF LIGHT FIXTURES



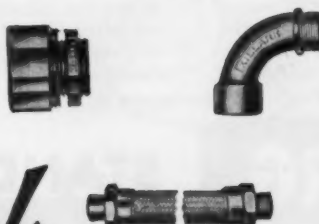
EXPLOSION PROOF PLUGS AND RECEPTACLES



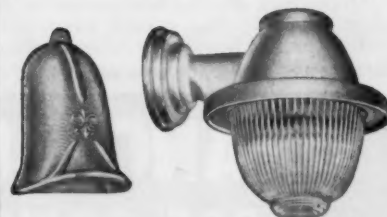
SEALED BEAM FIXTURES



ACCESSORIES



SPECIAL FIXTURES



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# LONG LIFELINES

Since 1893, Orangeburg has served the Power and Light, Telephone, General Construction, Municipal and Industrial fields. Orangeburg Fibre Conduit's record for giving complete protection to underground electrical cables at minimum cost is well known.

Orangeburg material is impermeable, the joints are water-tight — no corrosive ground waters get in. *Smooth bore* reduces pulling tensions on cables to minimum — safeguards

ORANGEBURG MANUFACTURING CO., INC.

the cable sheath from abrasion. Non-metallic Orangeburg does not corrode — resists acids, alkalies, salt, grease, oil. It is lightweight — yet tough, strong and resilient.

Orangeburg is a leader in every city and state. It saves money for users by faster handling, tooling and laying. A complete line of fittings, angle couplings, bend sections, bell ends . . . mean speed of installation . . . prevent costly delays. For more facts write Dept. EC-55.

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**FIBRE CONDUIT**

**STANDARD** INSTALLED WITH CONCRETE  
**NOCRETE** INSTALLED WITHOUT CONCRETE

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# Amprobe world's largest-selling snap-around volt-ammeter

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**AMPROBE  
JUNIOR**  
One low-cost  
tester measures  
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ELECTRICAL CONSTRUCTION AND MAINTENANCE . . . MAY, 1955



**Wagner®**  
**TRANSFORMERS**  
 ... the choice of leaders  
 in industry

for shorter runs of copper...  
 reduced line losses...  
 lower installation expenses...  
*get the right voltage  
 close to the load*  
 with a

## Wagner Dry-Type Transformer

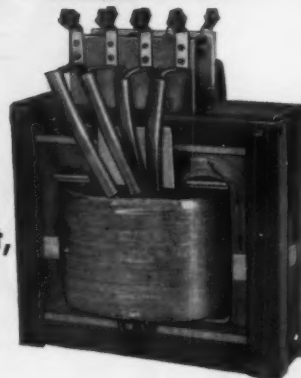
Wagner Dry-Type Transformers give dependable power distribution right at the load... close to your portable tools, machines or lighting system. This means a big savings to you in terms of shorter runs of copper, reduced line losses and lower installation expenses. Not only that, Wagner Dry-Type Transformers are compact, light in weight and safe to use—even in the presence of fire hazards.

The new 150° rise, totally-enclosed dry-type transformer with silicone insulation, is designed especially for use where ventilated transformers are impractical. When you install these transformers, fireproof vaults and other protective enclosures are unnecessary. Core and coil is protected from lint, moisture, dust and other contaminating materials by totally-enclosed sheet steel cases... and this kind of protection reduces maintenance to almost nothing. They can be installed outdoors, because their construction is completely weatherproof.

The 150° rise transformer is standard in ratings 3 through 10 kva and is also available through 50 kva. The 55° rise model is standard in 1, 1½ and 2 kva and the 80° rise transformer is standard in ratings 15 through 100 kva.

**Wagner®**  
**Form W**

**Core and Coil  
 permits compact,  
 lightweight  
 transformers...**



The heart of each Wagner Dry-Type Transformer is the famous Wagner Form W Core and Coil assembly. Core is of cold-rolled oriented grain transformer steel. The Form W design permits less weight per kva and small size cases for space saving installation.



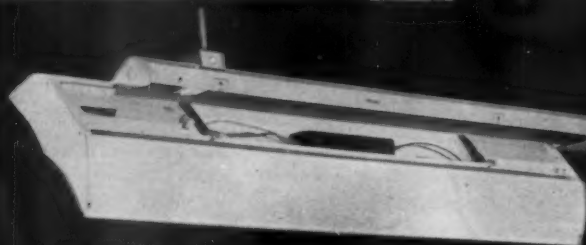
**Wagner Electric Corporation**  
 6413 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

never before  
an industrial  
with these  
unparalleled  
advantages



**ortho-88**  
Trade Mark



Patent applied for



Write Today ... for brochure giving complete details of the remarkable new Ortho-88. In addition to installation and mounting data, it illustrates several examples of how Ortho-88 versatility can work for you. Catalog pages giving complete engineering data are included.



Here's what advance design can do for you ...

**Save up to 50% on installation costs:** The Uni-Zone (shown above) is part of your Ortho-88. It is a rigid, lightweight, open channel-way containing a fixed power source (receptacle) for each fixture. Sections, 20-30 ft. long, are assembled and wired on the floor and hung as a unit. Fixtures, mounted without tools in minimum time, fall into perfect alignment automatically. The whole operation is accomplished easier, faster and more accurately with savings in time and materials up to 50%.

**Save on materials:** The amount of conduit required is reduced substantially. Receptacles, chain suspension accessories, cord and plug, etc. are completely eliminated.

**Unheard-of flexibility for you:** Fixtures may be mounted on the Uni-Zone in channels to be spaced at intervals of 4', 8' or 12'. They can be moved about, or additions made, as conditions demand without further electrical work and without interrupting service. Repairs or replacements are made by changing fixtures without disturbing other fixtures on the circuit.

**GIBSON**

*Manufacturing Co.*

1919 Piedmont Circle, N.E., Atlanta, Georgia

Model 41 Unconditionally Guaranteed

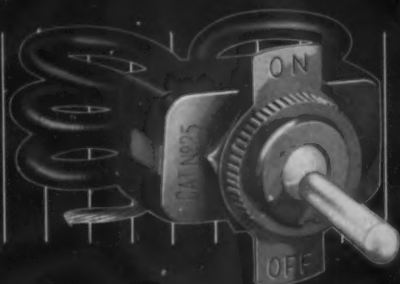


eliminate switch failures with  
**THE SWITCH THAT'S always READY**

Pampered in production to withstand abuse in use, the Levolver® #41 switch retains its positive action even after hundreds of thousands of pulls. It is unconditionally guaranteed against failure in lighting circuits. Its one-piece molded phenolic case insures better insulation, makes wiring easier. Removal of the mounting nuts lets the mechanism slip out, exposing terminals. A 6 amp "T" 125 volt switch, it is only  $\frac{5}{8}$ " x  $1\frac{3}{8}$ " x  $1\frac{3}{8}$ ". Ideal for individual control of lighting fixtures.



Levolver® No. 25



Specify *Levolver* for  
Dependability in Toggle Switches

The Levolver® No. 25 Toggle Switch is "T" rated for 6 amps — 125 volts and especially dependable for FHP motors on quality appliances, portable tools and for panel boards. Only  $\frac{1}{2}$ " thick,  $\frac{1}{2}$ " wide and 1" long. The molded phenolic case is dust and vibration proof. 6" wire leads with choice of colored levers for easy identification of circuits. Available also in three way and two circuit models with lugs or screw terminals.

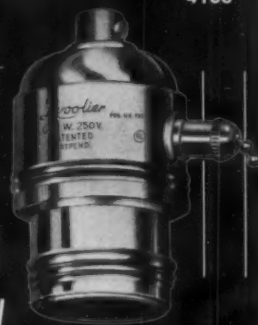
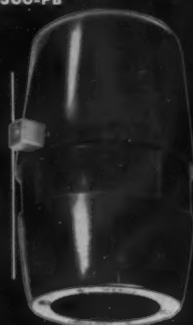


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**McGILL**  
QUALITY

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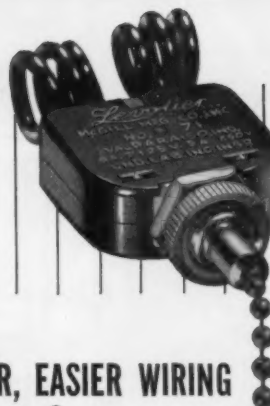
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NEW

Industrial LAMP HOLDERS with  
*Levolver*® Switch Dependability

Whether you prefer universal lever or the new push button control, you can have a Levolver Lampholder that has a proven record of long service in strenuous industrial use. Levolver switch mechanisms are built into both brass and molded phenolic heavy duty lampholders in a variety of single or two circuit models. All are built to eliminate failures in plant and machine lighting that can mean costly production time losses.



For FASTER, EASIER WIRING specify  
*Levolver*® No. 71 switches

A single pole, single circuit switch, the Levolver® No. 71 model is the thinnest 6 amp "T" 125 volt switch on the market today. Only  $\frac{15}{32}$ " thick, it insures quicker and easier installation because of the 6" wire leads that are permanently fastened to the terminals by pressure connections. Standard finishes: brass, dark bronze and burnished nickel, with brown molded phenolic case. The No. 71, like all Levolver switches, is Underwriters' approved.



Available through leading Electrical Wholesalers

For complete information on products of the McGill Electrical Division, write today for Catalog No. 49-A.

**McGILL MANUFACTURING COMPANY, INC.**  
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*Fluorescent Lighting*

*Costs Less When You Use*

## **FLEUR-O-LIER FIXTURES**

You can buy fluorescent lighting 2 ways: 1. Initial Low Cost — or 2. Long-Term Economy.

Fixtures that carry the Fleur-O-Lier label usually aren't found in the Initial Low Cost group. But the quality built into every Fleur-O-Lier fixture assures you of maximum Long Term Economy.

You'll get better, more satisfactory, and more economical fluorescent lighting with Fleur-O-Lier luminaires because:

1. Mechanical and electrical construction meet rigid specifications.
2. Only Certified CBM Ballasts are used.
3. Only Certified Starters are used.
4. Complete photometric test data, including distribution curves and coefficients of utilization are provided to tell you *in advance* the lighting results you'll get.
5. Electrical Testing Laboratories, Inc., test, check and certify that fixtures conform to all the above before they can carry the Fleur-O-Lier label.

For assured fluorescent satisfaction and economy . . .

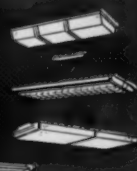
*Make Certain Your Fixtures are FLEUR-O-LIER*

### **FLEUR-O-LIER**

**Manufacturers**

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Fleur-O-Lier is not the name of an individual manufacturer, but of a group of fixtures made by leading manufacturers. Participation in the Fleur-O-Lier program is open to any manufacturer who complies with Fleur-O-Lier requirements.



**Four Steps That Mean**

**Easier, Quicker, Safer Installation of**

# **CRESCENT**

## **A B C ARMORED CABLE**



**1** FILE OR SAW  
GUIDED BY CUTMARK



**2** BREAK ARMOR



**3** PULL OUT PAPER



**4** INSERT INSULATING  
BUSHING



★ **NOTE CUTMARK** on the fourth turn from right on armor of cable above. This cutmark (at 1½" intervals) shows the location of a prefabricated breaking line inside the armor. Only a few strokes of a file or saw guided by the cutmark are required to cut through one outer ridge, and a bend by hand severs the armor. This results in a clean separation with no sharp edge—a safer, easier and faster job. The prefabricated breaking lines are so designed that there is *no reduction* in tensile strength, bending quality, crushing resistance and electrical conductivity of armor.

★ **NOTE BOND WIRE UNDER ARMOR** which is in contact with the under side of each convolution. This provides permanently low armor resistance. It is furnished in sizes No. 14 and 12 AWG Cable.

★ **GENUINE A B C CONSTRUCTION** provides for easy insertion of the insulating bushing because the paper under the armor readily *unwraps from under both ends* providing space to insert the bushing.

★ **ALL GLASS BRAIDS** protect the rubber insulated conductors, and are flame, moisture and rot proof. The use of ALL GLASS braid results in a cable with smaller diameter and lighter weight, being easier to handle and install.



# **CRESCENT**

## **WIRE & CABLE**

**CRESCENT INSULATED WIRE & CABLE CO.**

TRENTON, N. J.



*Right off your Square D  
Distributor's shelf!*

## New QMB Saflex Distribution Panelboard



Exactly the Power Panelboard you want—when you want it. Your Square D Distributor stocks boxes, interiors and plug-in units which can be quickly assembled to meet virtually any specifications. Above, interior ready for easy mounting in box.



Plug-in Units are installed easily on tubular bus bars. The solid neutral can be changed in minutes. Here is flexibility that reduces "down time" and saves money.



Three Simple Assembly Steps  
Fronts, with adjustable trim clamps, are available with or without doors.

### With ALL these Quality Features

INTERIORS are flexible and adaptable to almost any service and voltage. Plug-in units and solid neutral can be changed simply and quickly.

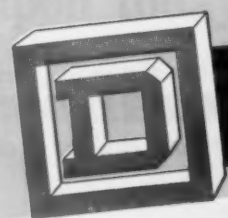
BOXES provide generous wiring space.  
FRONTS furnished with or without doors have adjustable trim clamps.

UNITS have quick-make, quick-break switch mechanism, visible blades and are horsepower rated. 30, 60, 100 and 200 ampere units are plug-in, while 400 and 600 ampere units are bolted to the bus.

Underwriters' Approved for Service Entrance



ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS



# SQUARE D COMPANY

# Get this FREE Home Wiring Wall Chart!

It's a ready  
check list of  
typical home  
wiring loads  
and circuits!



You'll want to post this handy and practical chart on the walls of your offices or estimating rooms. Wherever it's used, you'll find it a valuable check list when you're planning home electrical systems.
















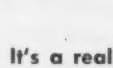
## AUTHORITATIVE!

The wiring facts shown by this chart were worked out in collaboration with leading electrical contractors and modern adequate wiring experts. You can be sure of the facts it contains.

Typical loads and circuits for kitchen, laundry, living areas and fixed utilities are shown. Also typical power center and circuit requirements for a six-room house.



## LOAD AND CIRCUIT

KITCHEN							
	Typical Wattage	Preferred Circuit	Volts	Wires	Breaker or Fuse	Number Outlets	
 RANGE	12000	10 KW.	120/240	3 #6	50A. 60A.	1	
 OVEN (Built in)	4500	6 KW.	120/240	3 #10	30A.	1	
 RANGE TOP (Heavy Duty)	6000	6 KW.	120/240	3 #10	30A.	1	
 RANGE TOP	3300	4 KW.	120/240	3 #12	20A.	1 or more	
 DISHWASHER	1200	2 KW.	120	2 #12	20A.	1	
 WASTE DISPOSER	300	2 KW.	120	2 #12	20A.	1	
 BROILER	1500	2 KW.	120	2 #12	20A.	2 or more	
 FRYER	1300	2 KW.	120	2 #12	20A.	2 or more	
 COFFEEMAKER	1000	2 KW.	120	2 #12	20A.	2 or more	
 REFRIGERATOR	300	2 KW.	120	2 #12	20A.	2	
 FREEZER	350	2 KW.	120	2 #12	20A.	2	
LAUNDRY							
	Typical Wattage	Preferred Circuit	Volts	Wires	Breaker or Fuse	Number Outlets	
 WASHING MACHINE	1200	2 KW.	120	2 #12	20A.	1	
 DRYER	5000	6 KW.	120/240	3 #10	30A.	1	
 IRONER	1650	2 KW.	120	2 #12	20A.	1	
 HAND IRON	1000	2 KW.	120	2 #12	20A.	2 or more	
 WATER HEATER	3000						

## KING-SIZED!

It's a real king-sized chart, twenty inches deep by two feet, 3½ inches wide. You'll find its large type easy to read. Printed in 2 colors on heavy stock, it stands up under long use. Send coupon for your FREE copy today!



# Kennecott Copper Corporation

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# CHART FOR HOME WIRING SYSTEMS

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Typical Outlets	Notes
	Use of more than one outlet is permitted, but not recommended.
	Appliance may be direct connected.
	Appliance may be direct connected.
	These appliances may be direct connected on a single circuit. Grounded receptacles required, otherwise.
	Heavy duty appliances regularly used at one location should have a separate circuit. Only one such unit should be attached to a single circuit at a time.
	Separate circuit serving only refrigerator and freezer is recommended.
	Notes
	Grounding type receptacle required.
	May be direct connected—must be grounded.
	Grounding type receptacle required.
	Consider possible use in other locations.
	Consult Utility Co. for load requirements.

# LIVING AREAS

	Typical Wattage	Preferred Circuit	Volts	Wires	Breaker or Fuse	Number Outlets	Typical Outlets	Notes
WORKSHOP	1500	2 KW.	120	2 #12	20A.	2 or more		Separate circuit recommended.
PORTABLE HEATER	1300	2 KW.	120	2 #12	20A.	1		Should not be connected to circuit serving other heavy duty loads.
TELEVISION	300	2 KW.	120	2 #12	20A.	2 or more		Should not be connected to circuit serving appliances.
PORTABLE LIGHTING	1200	2 KW.	120	2 #12	20A.	2 or more		Provide one circuit for each 500 sq. ft. Divided receptacle may be switch controlled.

# FIXED UTILITIES

	Typical Wattage	Preferred Circuit	Volts	Wires	Breaker or Fuse	Number Outlets	Typical Outlets	Notes
FIXED LIGHTING	1200	2 KW.	120	2 #12	20A.	2 or more		Provide at least one circuit for each 1200 watts of fixed lighting.
AIR CONDITIONER 3/4 H.P.	1200	2 KW.	120	2 #12	20A.	1 or more		Consider 4 kw 3-wire circuits to all window or console type air conditioners. Outlets may then be adapted to individual 120 or 240 volt machines.
AIR CONDITIONER 1 1/2 H.P.	2400	4 KW.	120/240	3 #12	20A.	1 or more		
CENTRAL AIR CONDITIONER	5000	6 KW.	120/240					Consult manufacturer for recommended connections.
SUMP PUMP	300	2 KW.	120	2 #12	20A.	1 or more		May be direct connected.
HEATING PLANT	600	2 KW.	120	2 #12	20A.	1		Direct connected. Some local codes require separate circuit.
BATHROOM HEATER	1500	2 KW.	120	2 #12	20A.	1		Direct connected.

## TYPICAL POWER CENTER AND CIRCUIT REQUIREMENTS

6 ROOM HOUSE 1500 sq. ft.

20-kw Service	main	100 amp 3w	240/120 volts	Dish Washer	1-2 kw	20 amp 2w	120 volts
10-kw Range	1-10 kw	50 amp 3w	240/120 volts	Oil Burner	1-2 kw	20 amp 2w	120 volts
3-kw Water Htr.	1-4 kw	30 amp 3w	240/120 volts	Freezer-Ref.	1-2 kw	20 amp 2w	120 volts
5-kw Dryer	1-4 kw	30 amp 3w	240/120 volts	Heater	1-2 kw	20 amp 2w	120 volts
1 1/2-hp Cooler	1-4 kw	20 amp 2w	240 volts	T.V.	1-2 kw	20 amp 2w	120 volts
Clothes Washer	1-2 kw	20 amp 2w	120 volts	General Purpose	4-2 kw	20 amp 2w	120 volts
Ironer	1-2 kw	20 amp 2w	120 volts	Portable App.	3-2 kw	20 amp 2w	120 volts

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Your copy of this FREE home-wiring wall chart will be sent to you immediately.

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Please send me without obligation on my part, your free wall chart showing typical loads and circuits for home wiring systems.

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**FOR OVER SIXTY YEARS**



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P&S 1591-I

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Trade Mark

The first truly modern switches — Combine functional design — quiet operation — and glow in the dark. The classic knob blends with modern interiors. Available in conventional strap type or P&S Despard type for combination wiring. Can be used to full current rating on fluorescent lighting loads.

**switches**

**good**

**better**

**best**

Totally Enclosed Plastic. Residential type. Brown S.P. 1871, 3-W 1873. Ivory S.P. 1971, 3-W 1973



P&S 1871

Totally Enclosed Plastic. T-Rated. Meets Fed. Spec. W-S-896. Brown S.P. 7301, 3-W 7303. Add "I" for ivory.



P&S 7301

First Quality. T-Rated. Meets Fed. Spec. W-S-896. Brown S.P. 1815-D, 3-W 1835-D. Ivory, 1915-D and 1935-D



P&S 1815-D

**outlets**

**good**

**better**

**best**

Parallel Slots. Single Grip Contacts. Plaster Ears. Brown 1565. Ivory 1565-I



P&S 1565

Double Grip Contacts. Screwless Terminals. Meets Fed. Spec. W-R-151-a. Brown 1500. Ivory 1500-I



P&S 1500

First Quality, T-Slot Outlet. Meets Fed. Spec. W-R-151-a. Brown 1530. Ivory 1530-I



P&S 1530



P&S 5252

**3-wire grounding outlets**

Available in Duplex and Single, Brown and Ivory — and on Box Covers. Designed for laundry and kitchen circuits — meets new code requirements.



**P&S Despard line**

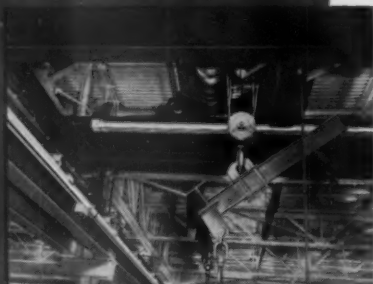
For the most modern buildings. Two or three compact Roto-Glo or lever type switches, outlets, pilots or night lights can be installed in the space ordinarily required for one conventional type switch.

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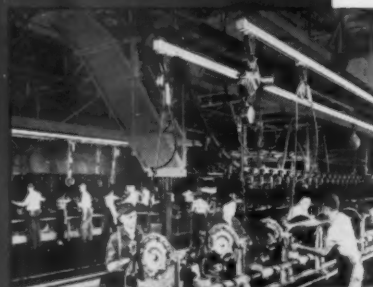
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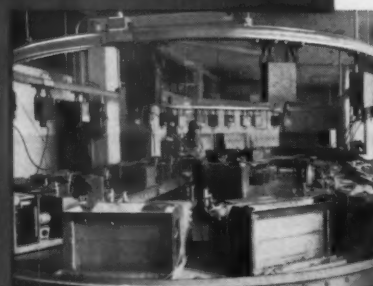
CRANES AND HOISTS



RECEIVING DEPARTMENTS



PRODUCTION LINES



TEST LINES



# Electrify

your production areas

for maximum

**CONVENIENCE**

**SAFETY and**

**FLEXIBILITY**

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## **FEEDRAIL<sup>®</sup>** **TROLLEY BUSWAYS**

With its steel enclosed power buses and free moving trolleys, FEEDRAIL gives you mobile electric power outlets anywhere along its length.

Superior to ordinary wiring methods, it provides a dependable power source for both stationary and moving equipment. Thus its uses in industry are myriad — from powering hoists and cranes to supplying current for portable electric tools; from the electrification of moving test lines to providing the power and control circuits on machine tools.

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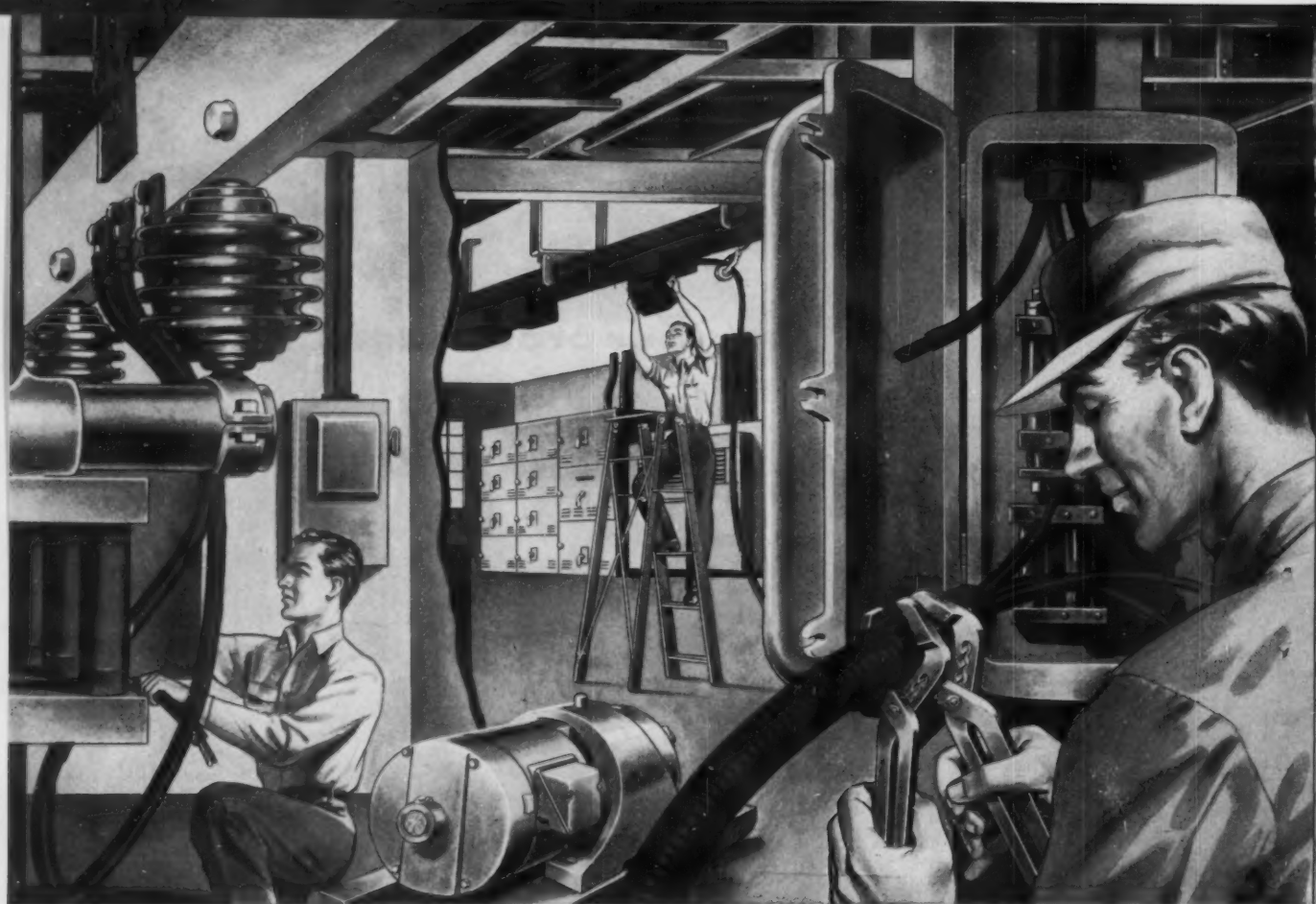
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## ***Master Electrical Specifications***

Specifications perform many useful functions in the construction industry. They can all be summed up in one word—communication. Any structure is a complex of arts, technologies and crafts which must have orderly integration and clear purpose. Tasks must be defined and allocated. Particular skills and qualities must be chosen and employed to the best advantage. And specifications are the means of communication which guide the many operations imperatively toward the goal of a finished project.

The familiar job specification which accompanies the plans are only the formal documentary phase of the specification process. It was preceded by the translation of an idea into a broad outline of practical dimensions, basic materials and services. It will be followed by more detailed specifications as each contractor and supplier interprets its requirements for the specifics of his own services, workmanship and materials.

Electrical work is particularly sensitive to good specifications. Hundreds of different products from different manufacturers must be brought together under exacting direction and with great skill to work in interdependent systems. The art itself is growing, presenting serious problems of system selection and future capacity. And the terms of current specifications inexorably define the practical frontiers of electrical progress.

Our major editorial project this month is the seventh edition of the Master Electrical Specifications. It is, in token of the importance of the subject to the industry, the largest single editorial feature project we publish. If printed in conventional book form it would require a complete volume of over 300 pages.

The Master Electrical Specifications is essentially a practical tool; a manual of specification procedure and a guide for those who must write, use or understand electrical construction specifications in the course of their daily responsibilities. The method of presentation is also practical and easy-to-use. The types of information that the specifications should describe and the various considerations to observe are given in light face type followed by specification paragraphs in bold-face type. The specifications are either sample, composite or prototype paragraphs which are easily modified to fit specific job requirements.

The best of specifications, however, can only implement the engineering concepts they describe and the plans they complement. They cannot take the place of experienced engineering design and layout, nor can they eliminate the necessity for contracting with firms of known responsibility, skill and experience.

*Wm. T. Stuart*

# 1.0 General Conditions

General Conditions of a specification are those which refer to the project as a whole and which apply to all contractors and suppliers involved in the work.

Depending upon size and importance of the project, these conditions may consist of a few paragraphs or may include hundreds of pages of detailed instructions.

To facilitate fast and accurate references within the specification, long and detailed directives are indexed. One of several recommended indexing methods is the "decimal system" which is used throughout this master specification. As noted, this indexing system refers to main sections by whole numbers, such as 1.0, 2.0, 3.0, etc. Subheads are indicated by a numeral after the decimal, such as 1.2, 2.3, 3.4, etc. And clauses containing additional information for the contractors are indicated by a second numeral after the decimal, such as 1.23, 2.45, 4.62, etc.

Using this decimal system, the General Conditions covering a specific project could be amplified in accordance with the following outline:

## 1.1 Defining the Project

1.11 General description of property; building layout, construction, height, type of occupancy, boundary lines, address.

1.12 Scope of the work; listing all systems that are to be included in the contract and which will be discussed in detail in subsequent sections of the specifications. This section should also specify what is *not* to be included, or that which is to be performed by other trades.

1.13 Drawings related to the specifications; also discussion of possible changes which may be dictated by local conditions at a later date. Some specifications also direct the contractor to submit a final set of corrected "as installed" drawings upon completion of the work.

1.14 Symbols and abbreviations.

1.15 Definition of terms.

1.16 Addendums, alternates, revisions.

1.17 Examination of the site to eliminate misconceptions of fact and to verify dimensions, available utility services, features of topography, transportation provisions, storage facilities.

1.18 Surveys for datum planes, elevations, benchmarks and stakes; how to request and by whom to be made.

## 1.2 Bids and Schedules

1.21 Method of submitting bids; to whom, when, where and in what form.

1.22 Time schedules, work programs, layout of work.

1.23 Inspection, supervision, approvals.

## 1.3 Governing Conditions

1.31 Codes, regulations, safety orders, building laws and ordinances, such as the National Electrical Code, the American Institute of Architects' contract for the Construction of Buildings, State Industrial Accident Commission orders, plus any other national, state, municipal, utility or company directives relating to the contemplated type of work.

1.32 Code rulings and interpretations, by whom rendered in event of question.

1.33 Arbitration of errors or conflicts.

1.34 Responsibility, status and definition of owner, architect, engineer and contractor.

## 1.4 Financial Considerations

1.41 Insurance coverage for fire, theft, public liability, workman's compensation.

1.42 Bond for evidence of financial responsibility.

1.43 Local fees related to securing all required permits, certificates.

1.44 Method of payment, governed by either prefixed dates, progress reports, progress photographs, payroll, bills of material, final payment.

1.45 Withholding Social Security deductions from payroll of workers.

1.46 Liens.

1.47 Responsibility for taxes.

## 1.5 Protection

1.51 Physical precautions related to protection of materials, tools, equipment, working personnel, public.

1.52 Enclosed storage areas, tool cribs, work sheds, field offices, general headquarters.

1.53 Provision of watchman service, fire extinguishers.

1.54 Guard rails around excavations or elevated work areas, padlocks on enclosures, notices and warnings

pertaining to high voltage, arm guards on saws and drills.

1.55 Approved tools, appliances, devices, scaffolding and hoisting equipment to be used in connection with the work.

## 1.6 Materials

1.61 Required standards, labels, approvals, tests, samples.

1.62 Specification by brand name and catalog number; "or approved equal" clauses, substitutions.

1.63 Quality of related hardware on the job.

1.64 Causes for rejection of materials or equipment.

1.65 Gauges of metal used in enclosures, wire and cable sizes.

1.66 How handled, how stored on premises, how protected against theft, damage or deterioration.

1.67 Delivery, on what dates and to what destination.

## 1.7 Labor

1.71 Governing labor laws, prevailing or acceptable wage scales to be followed.

1.72 Specification of labor force, such as ratio of foremen to journeymen to apprentices, etc.

1.73 Clauses pertaining to anti-discrimination, preference to handicapped workers or veterans, seniority.

1.74 Reasons for dismissal.

## 1.8 Approvals

1.81 Claims for extension of deadlines, overtime pay.

1.82 Permissible causes for suspending work.

1.83 Revision of plans in the field, substitution of materials, departure from recommended method of installation, conflicts between plans and specifications.

## 1.9 Temporary and Related Conditions

1.91 Electric service for lighting, power and heat during period of installation.

1.92 Advertisements, signs, notices.

1.93 Use of installation photographs for commercial purposes.

1.94 Cutting and patching.

1.95 Excavation and backfill.

1.96 Installation of sleeves.

1.97 Repair and maintenance.

1.98 Removal of debris from

premises during and after completion of work.

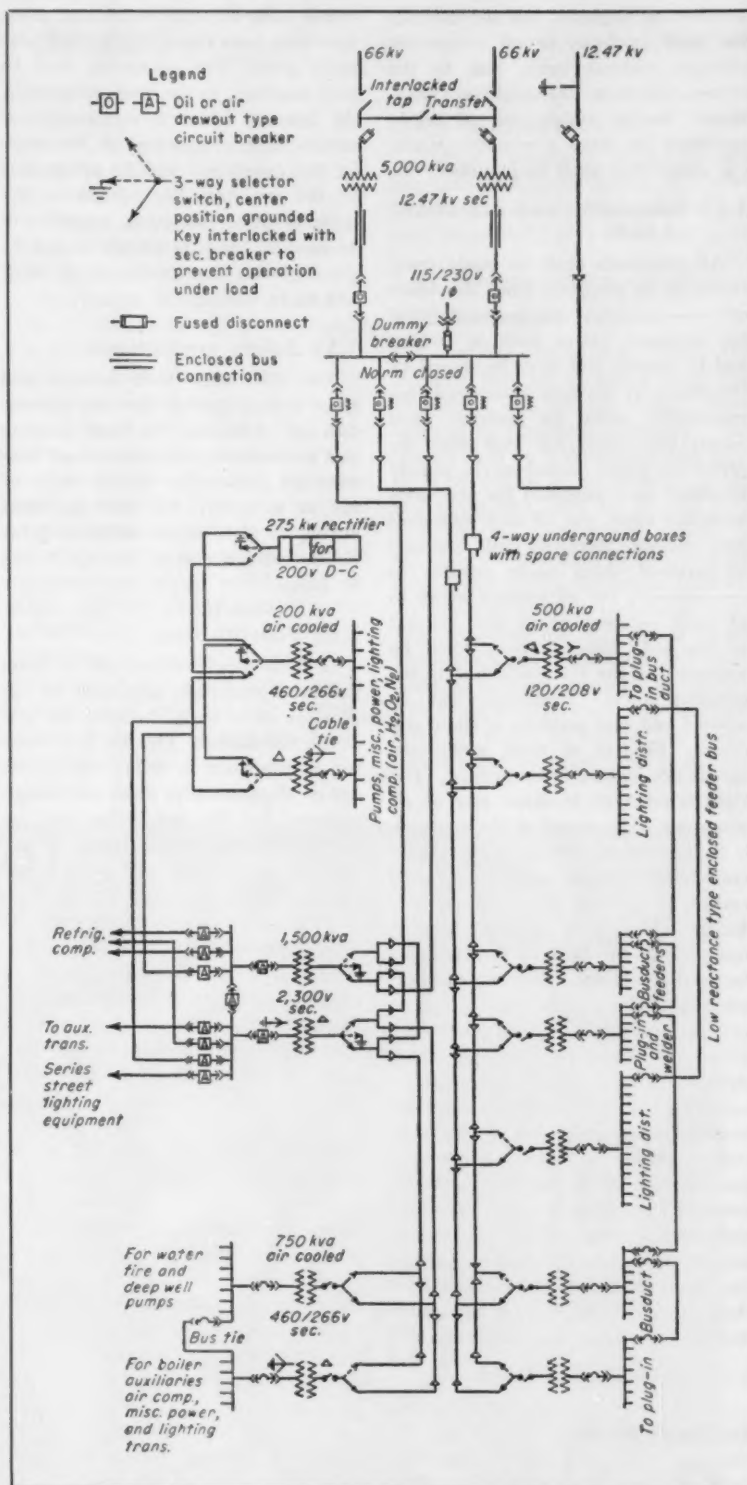
To protect all parties involved in a contract, all possible causes for misunderstanding should be eliminated in the specification. Therefore any conditions contained in the document should be presented in detailed form. For example, typical clauses from the General Conditions of a specification would probably appear as follows:

### 1.12 Scope.

The work to be done shall include the furnishing of all labor, materials, appliances, equipment, tools, transportation, superintendence and services required to construct and install, complete and operative, the following electrical system as herein specified and shown on the accompanying drawings: service busways; power and lighting distribution systems; headers, fittings, floor outlets and finishing hardware for Q-floor system; empty conduit systems for telephone, public address, fire alarm, program clocks, etc. Work to be performed or installed by others (as listed in detail) shall be coordinated, with the electrical contractor providing and installing all necessary anchors, sleeves, hangers, etc., for attaching or connecting his work to related work of other trades.

### 1.13 Drawings.

The drawings which constitute a part of this contract indicate the general arrangement of circuits and outlets, locations of switches, panels, boards, conduit and other work. Data presented on these drawings are as accurate as preliminary surveys and planning can determine, but accuracy is not guaranteed and field verification of all dimensions is directed. Specifications and drawings are for assistance and guidance, but exact locations, distances and levels will be governed by actual field conditions. Electrical contractor shall also review architectural, structural, plumbing, heating and ventilating plans, and shall adjust his work to conform to all conditions shown thereon. Discrepancies shown on different plans, or between plans and actual field conditions, or between plans and specifications shall be promptly brought to the attention of the (inspector, engineer, architect, etc.) for a decision. These drawings may be superseded by later detailed drawings or addenda to the specifications prepared by the



Detailed plans are an integral part of electrical specifications, and plans include schematic distribution diagrams, such as the above, plus specific floor and ceiling wiring layouts, installation details, symbols, reference notes and the like, submitted to the contractor for his guidance and direction in bidding. The above distribution system covers an installation which includes several voltage levels, a banked secondary busduct installation, protective equipment plus transfer equipment for temporarily bypassing faults, or for segregating sections of the system during periods of alteration, expansion or maintenance.



architect or engineer, and the contractor shall conform to all reasonable changes without extra cost to the owner. All items not specifically mentioned herein which are obviously necessary to make a complete working installation shall be included.

#### **1.21 Submission and execution of bids.**

All proposals shall be made upon forms to be obtained from the office of———. All proposals shall list proposed prices both in writing and in figures, and shall be signed by the bidder or his duly authorized representative, with his address, firm name, title, etc. All bids shall be presented under sealed cover plainly identified as a proposal for the work being bid upon, and all such bids shall have enclosed therewith cash, cashier's or certified check made payable to———, for an amount equal to at least — percent of the amount of the bid. Bidder's bond shall be executed on the form attached to the proposal form. Proposals will be opened and read publicly at (time and place). Bidders or their authorized agents are invited to be present. The right is reserved to reject any or all proposals. The award of the contract, if it is awarded, will be to the lowest responsible bidder whose proposal complies with all requirements prescribed. The award, if made, will be made within — days after the opening of the proposals. Within — days after the bids are opened, the owner or his representative will return the proposal guarantees accompanying such of the proposals as are not to be considered in making the award. The contract shall be signed by the successful bidder in duplicate counterpart and returned, together with the contract bond, within — days (not including Sundays) after the bidder has received notice that the contract has been awarded. The contractor shall also sign a set of plans and specifications for filing with the contract.

#### **1.44 Method of payment.**

At the end of each calendar month, the contractor shall submit to the engineer a statement of all materials actually placed in the building during the month, the labor expended thereon, and the cost thereof; whereupon after verification by the engineer, and it is found to be correct, a certificate for the amount less — percent thereof will be issued by the engineer, but no certificate will be

issued until defective work and materials have been removed, replaced, and made good. The contractor shall be paid monthly, as the work progresses, the amount of such certificates. A month after completion of the work by the contractor and its acceptance by the engineer, the balance of the contract price remaining unpaid will be paid under a certificate issued by the engineer. Acceptance of all work will be in writing.

#### **1.51 Safety precautions.**

The contractor shall furnish and place proper guards for the prevention of accidents. He shall provide and maintain any other necessary construction required to secure safety of life or property. He shall maintain during all night hours sufficient lights to prevent accident or damage to life or property.

#### **1.62 Substitutions.**

In these specifications, one or more makes of materials, apparatus or appliances have been specified for use in this installation. This has been done for convenience in fixing the standard of workmanship, finish and design required for this installation and the details of the workmanship, finish, and design and the guaranteed performance of any material, apparatus or appliance which the contractor desires to substitute for those mentioned herein shall also conform to these standards. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be used, providing it conforms to the requirements of these specifications and meets the approval of the architect and engineer. Should the contractor desire to substitute other makes of materials, apparatus or appliances than those mentioned herein, he shall make the request in either one of the two following ways. (1) By separate alternate proposal, based on furnishing and installing the proposed substitute. Such proposal shall be accompanied by complete plans and specifications of the substitute. (2) By making a request within ten days after the award of the contract, to be allowed to make the substitution. This request shall be accompanied by complete plans and specifications of the substitute offered. If so requested by the architect or engineer, this contractor shall also submit samples of both the specified material or ap-

pliance and the substitute. In the event that substitutes are accepted, the cost of which is less than those specified, then the contract price shall be reduced by an amount equal to the difference in cost between them, plus 10% of the difference.

#### **1.72 Supervision.**

The contractor shall personally, or through an authorized and competent representative, constantly supervise the work from its beginning to its completion and acceptance. He shall so far as possible keep the same foreman and workmen on the work from its commencement to its completion. During its progress the work shall be subject to inspection by representatives of the State and municipality, at which times the contractor shall furnish required information.

#### **1.82 Suspending work.**

In the event that a national emergency occurs, or work is impractical because of freezing weather or diversion of critical materials, equipment or labor, as a result of an order or proclamation by the President of the United States, or of an order of any federal authority, and the circumstances or conditions are such that it is impractical or unreasonable to proceed with a substantial portion of the work, then the contractor may request in writing suspension of work.

#### **1.96 Sleeves.**

The contractor shall place sleeves in forms of walls, floor slabs and partitions, for the passage of all conduits, pipes and ducts installed by him. Sleeves should be set in place a sufficient time ahead of the concrete work so as not to delay that work. Sleeves for covered pipes shall be large enough to allow the covering to be placed on the pipe inside of the sleeve. Sleeves shall be made of galvanized sheet steel of—gauge, securely fastened in position. Conduits in outside walls (for underground service entrances and the like) should be installed in the center of sleeves, and the annular space filled with oakum loosely packed in place. The ends of the packing, both inside and outside, should be sealed with an approved make and grade of asphalt, applied (hot or cold). To retain sealing compound, the conduit shall be fitted on each side of the wall with a round flange made of galvanized steel not less than—of an inch thick, fastened to the conduit by not less than — set screws.



## 2.0 Service Entrances

An electrical service includes all conductors and equipment necessary to deliver energy from a main utility supply system to the wiring system of the individual premises being served. Therefore its specification should include all mediums (either overhead or underground) installed to carry power from a utility pole line or transformer to the building proper, plus all equipment and accessories required for power cutoff or interruption, primary metering and grounding.

Depending upon size of installation, voltage levels, means of routing and possibility for mechanical injury to conductors, incoming service systems may incorporate enclosed busways, specially designed bus bar structures, multiple conductors per phase enclosed in parallel conduits or ducts, flexible conduit, special insulations or open wiring on cleats and insulators. In all cases the specifications should be explicit concerning size and number of cables, phase and

voltage characteristics, method of transporting and supporting the distribution mediums, details of installation and protection.

In cases where an interruption of electrical service would result in a major production loss, panic (such as in department stores) or endangerment of life (such as in hospitals), it is advisable to provide more than a single service entrance. Means for providing emergency power are also recommended in the forms of batteries or separate generators, with transfer switches provided to automatically shift the load from normal to emergency channels in the event of a utility power failure. These additional service sources should also be enumerated and clearly detailed in the specifications.

The Service Entrance section of a typical electrical specification could include any or all of the following examples of typical clauses which are indicated by boldface.

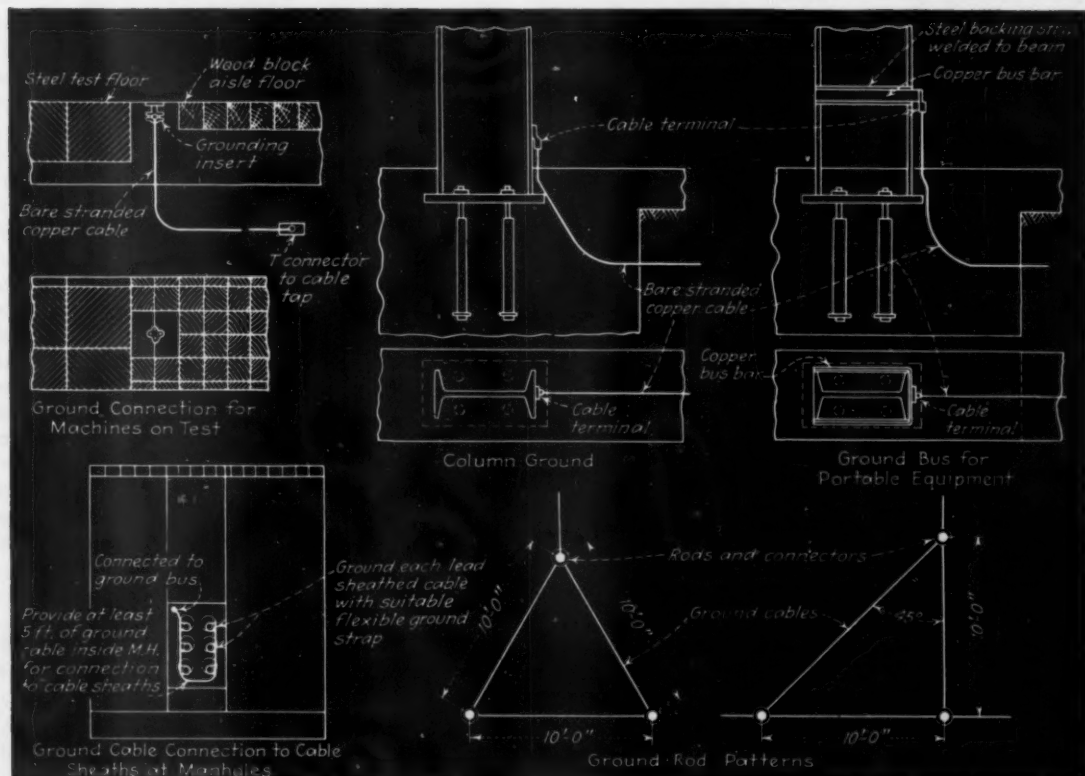
### 2.1 Characteristics

Voltage, frequency, phase and wire characteristics—also noted on drawings accompanying the specifications and considered a part of same.

#### 2.11 Primary service entrance.

#### 2.12 Secondary services.

Power for distribution within the building will be available from the secondary side of the transformers supplied by the utility company. This service shall be 3-phase 120/208 volts 60-cycle 4-wire ac, for normal power and light; and shall be 3-phase 440 volts 60-cycle ac for one section of the main switchboard, as indicated on the accompanying drawings. General arrangement of vault, switchgear room and connecting mains is shown on the Riser Diagram. This contractor shall make all connections to the secondary side of the transformers, and shall perform all wiring to the current transformers and tie buses. This contractor



Grounding details such as the above should be included on the drawings as well as being discussed in the specifications. These diagrams show details of ground connections for a testing laboratory; connections between grounding medium, steel building columns and portable equipment; grounding of lead cable sheath within a man hole, and several patterns for positioning driven rods.

shall furnish and install the tie buses, limiting lugs, terminals, etc., to make a complete connection in each case. Bus tie shall be 4,000MCM-AVA segmented cable. Terminals for secondary connections at the transformers shall be supported independently from the transformers so that any transformer can be removed without disconnecting the leads.

### 2.13 Auxiliary services.

(Including batteries, other voltages, ac plus dc, etc.)

### 2.14 Multiple entrances.

(For fire pumps, emergency lighting, varied occupancies, etc.)

## 2.2 Conductors

(List number, sizes, type of insulation, construction characteristics.)

### 2.21 Cables.

High and low voltage.

All high voltage cable shall be impregnated, varnished cambric, or paper insulated, lead covered insulated for voltage and sizes as specified or shown on drawings. Cable shall be of the very best obtainable quality, manufactured in accordance with the best acceptable practice. All such wire and cable shall be in accordance with, and conform to the latest requirements and specifications of the Insulated Power Cable Engineers Association. All high tension cables exposed in vaults, manholes, pull boxes or switch rooms or splice chambers and all locations not protected with conduit shall be fireproofed with two wrappings of 3/16-in. thick pure asbestos felted tape

backed with coarse jute cloth and covered with at least a 3/16-in. thick smear coating of asbestos cement. The felted tape shall be immersed in a solution of asbestos cement until it has become thoroughly impregnated and then wound spirally on cable with butted joints and without lap except at bends. The second layer shall be wound spirally in the opposite direction. The asbestos cement shall consist of a chemically neutral powder guaranteed to have no deleterious effect on the lead covering or braid of the cable and to withstand immersion either constant or intermittent without effect on the fireproofing or the mechanical qualities.

### 2.22 Connections.

Ahead of disconnecting means.

### 2.23 Splices.

Locations and methods for making connections, taps.

All high voltage splices shall be made with an approved splice for the cable furnished, and shall be of such quality as recommended by the manufacturer of the cable furnished. Splices shall be made by workmen familiar with this type of work.

### 2.24 Identification.

Tagging, color coding.

### 2.25 Testing.

## 2.3 Routing

### 2.31 Overhead.

From pole line, utility aerial supports, elevated transformer, etc.

### 2.32 Underground.

From street main, duct line, ground vault, etc.

### 2.33 Service drop.

Clearance from roof, ground, walls, windows, doorways, shafts, etc.

### 2.34 Potheads.

Means of attachment and mechanical protection. This clause also covers entrance heads, sealed raceways, entrance to building, connection to equipment.

High voltage cable shall terminate at potheads having the rated voltage and conductor capacity to accommodate the cable used. Mounting shall be as required for the conduit system installed. Potheads shall be filled with compound suitable for high voltage service. Care should be observed to avoid heating the compound to a higher temperature than that recommended by the manufacturer.

### 2.35 Ducts.

Also includes location and specification of other materials—rigid or flexible conduit, bus duct, concrete envelopes (including mix ratio, thickness, rodding), open wiring, type of pipe bends and elbows, transposition means (conduit-duct, cable-bus), etc.

Furnish and install three 4-in. conduits between the utility vault and the customer's vault as shown on the accompanying plans. Conduit shall be impregnated fiber of the best quality, properly seasoned and free of defects, furnished in the manufacturer's standard length and shall be of uniform wall thickness. Ducts shall have sleeve joints waterproofed with an approved compound. They shall be installed not less than 24 inches below the surface and shall be graded away from the interior vault. They shall be enclosed by a concrete envelope not less than 3 inches in thickness; the concrete having a mix ratio of — cement: — sand: — coarse hard gravel and water: cement ratio of —.

### 2.36 Structures.

Manholes, vaults, provision for pulling and racking cables, drainage, access.

## 2.4 Equipment

(This item may be expanded or completely covered in Section 4.0—Circuit Switching and Protection.)

Size of Largest Service Conductor or Equivalent for Multiple Conductors	For Wiring System and Service Equipment	For Service Equipment Only	For Service Equipment Only	Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment Conduit, etc. Not Exceeding (Amperes)	Size of Grounding			Conductor Electrical Metallic Tubing (Inch)
					Copper Wire No.	Conduit or Pipe (Inch)		
	Copper Wire No.	Conduit or Pipe (Inch)	Electrical Metallic Tubing (Inch)					
2 or smaller.....	8	3/4	3/2	20.....	16*	3/2	3/2	
1 or 0.....	6	3/2	1	30.....	14	3/2	3/2	
00 to 000.....	4	3/4	1 1/4	40.....	12	3/2	3/2	
Over 000 to 350,000 C. M.....	2	3/4	1 1/4	60.....	10	3/2	3/2	
Over 350,000 to 600,000 C. M..	0	1	2	100.....	8	3/2	3/2	
Over 600,000 to 1,100,000 C. M.	00	1	2	200.....	6	3/2	1	
Over 1,100,000 C. M.....	000	1	2	400.....	4	3/4	1 1/4	
				600.....	2	3/4	1 1/4	
				800.....	0	1	2	
				1000.....	00	1	2	
				1200.....	000	1	2	

\* Permissible only when part of an approved cable assembly.

Grounding conductors, sized in accordance with NEC Sections 2594 and 5, should equal or exceed the values given in this table. Values at left refer to grounding conductors for ac systems, common grounds or service equipment. Those at right refer to grounding conductors for interior conduit, cable sheath or armor, other metal raceways and equipment.

## 2.41 Disconnecting means.

Circuit breakers (manual, electrically operated, automatically tripped), switches and fuses (with ratings, characteristics, terminal connection means, construction details).

## 2.42 Overcurrent protection.

## 2.43 Transfer switches.

Automatic equipment for emergency service cutover.

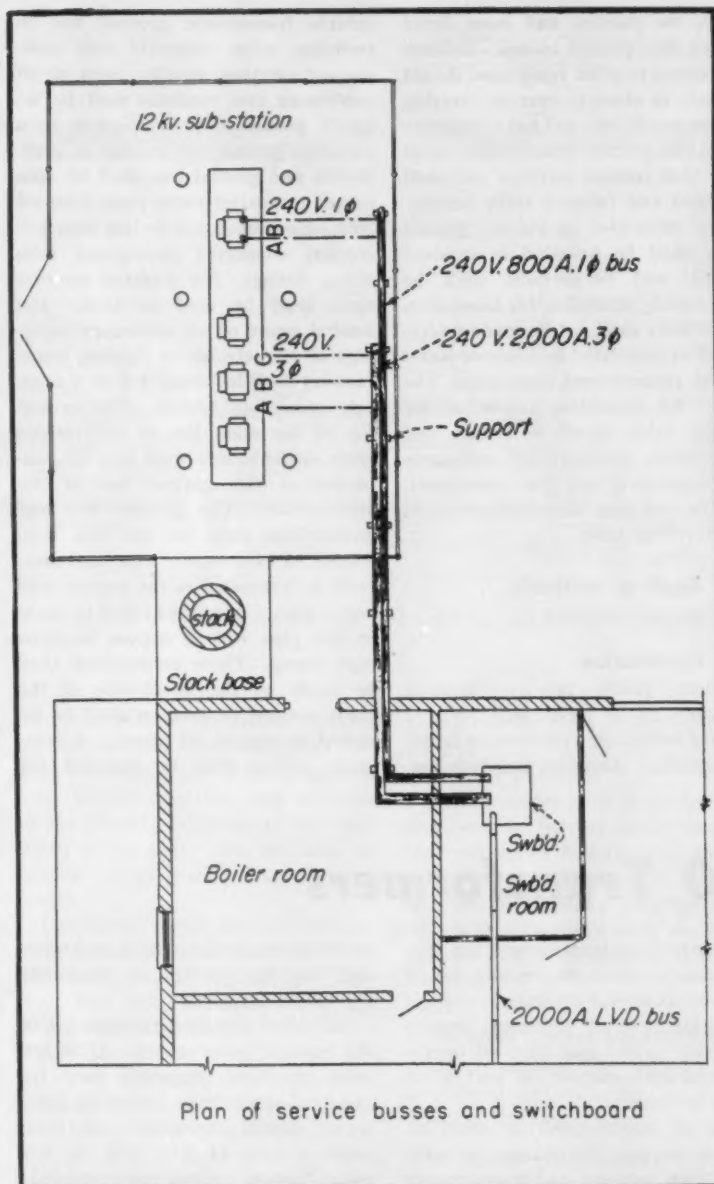
The automatic transfer switch shall consist of two 3-pole 600-volt ac 800-amp electrically operated dead-front circuit breakers, electrically interlocked and provided with under-voltage and time-delay relays to operate in the following manner: (1) In event of outage to normal service, breaker "A" shall open immediately, after which breaker "B" shall close, energizing the emergency section of the main switchboard; (2) After restoration of normal service for a period of two minutes, breaker "B" shall open and breaker "A" shall close. The operating mechanism and relays shall be of such design and so connected that the bus of the emergency section of the switchboard will not be de-energized for more than two seconds (providing either of the two incoming main services are energized). The operating mechanisms shall be provided with interlocks and relays to give "anti-pumping" protection, and to insure that the operation cycle will be completed, even if normal service is restored before completion of the cycle. Circuit breakers shall be as manufactured by \_\_\_\_\_.

## 2.5 Grounding

### 2.51 Terminal mediums.

Cold water piping system, metal framework of building with deep footings in moist earth, driven rods, buried plates or metal mesh arrangements.

Grounding shall be accomplished by means of "grounding assemblies." The single rod assembly shall consist of one — ground rod, — inch diameter and — feet in length; a — clamp at the top of each rod; and a bare stranded copper conductor from the clamp to the equipment to be grounded. The three-rod assembly shall comprise three — ground rods, each — inch diameter and — feet in length, spaced in the form of an equilateral triangle with rods 6 feet apart; a clamp at the top of one rod; a bare stranded copper conductor



Both single- and 3-phase power at 240 volts is supplied by this 12-kv substation, with enclosed feeder bus structures carrying these utilization voltages to the adjacent switchgear room.

from one of the clamps to the equipment to be grounded; and a bare stranded copper conductor circling the three rods and brazed to each one. Upper ends of the rods shall terminate 6 inches above the established grade. Grounding conductors forming the loop of the three-rod assembly and the lead from the three-rod and single-rod assemblies shall be bare stranded copper cable installed 2 feet underground from the rod to which it is attached, to the structure or equipment to be grounded. The

grounding conductor shall be brazed or bolted to the structures or equipment as directed by the engineers. The resistance between the ground cable and absolute earth shall not exceed — ohm and shall be measured in the presence of (authoritative personnel) before equipment is placed in operation.

### 2.52 Connecting mediums.

Cables, buses.

Grounding conductors should be so located as to permit as far as prac-



ticable, the shortest and most direct path to the ground clamp. Ground connections to plant equipment should be made as close to current carrying parts as practicable and not to separate feet. All ground connections shall have clean contact surfaces and shall be tinned and sweated while bolting. Unless otherwise specified, ground cables shall be installed in exposed conduit, and connections shall be made readily accessible for inspection. Connections shall not be made underground or concealed in floors or walls. Interior raceway and equipment: The size of the grounding conductor for conduit, cable sheath or armor, and other metal raceways or enclosures for conductors, and for equipment, shall be not less than that given in the preceding table.

### 2.53 Bonding methods.

To insure continuity.

### 2.54 Installation.

System points or fixed-location equipment to be included.

Large buildings: Transformer tanks, three-position disconnecting switches,

cubicle framework; ground bus in cubicles; cable supports and non-current carrying metallic parts of all equipment and conduits shall be securely grounded by connection to a common ground bus insofar as practicable and ground bus shall be connected to nearest water pipe. Ground connections shall not be less than 1/0 copper, connected throughout with clamp fittings. No soldered connections shall be used in leads. The neutral point of all secondary windings of all network or lighting transformers shall be connected to a separate grounding system. The neutral leg of the main bus at the various main switchboards shall also be connected to this ground bus at the switchboard. The ground bus and connections shall be not less than 500MCM bare copper wire, and same shall be connected to the nearest cold water pipe. Connections shall be made to this pipe with a copper or brass pipe clamp. These connections shall be made on the street side of the water meters, or jumpers shall be installed by-passing all meters. A complete system shall be installed for

each vault, and same shall be in accordance with the latest edition of the National Electrical Code. All ground conductors, and taps from equipment to bus shall be made with copper, with as few connections as possible. Bus shall be continuous without joints or splices throughout its length. All connections from bus to taps, and bus to bus shall be made with an approved type of solderless connector, and all grounding conductors shall be protected from mechanical injury, and shall be rigidly supported. If ground conductors are run through conduit they shall be securely bonded to such conduit at the entrance and exit.

All ground connections to equipment or conduit shall be made with an approved type of solderless connector, and same shall be bolted or clamped to equipment or conduit. All contact surfaces shall be thoroughly cleaned and bright before connection is made so as to insure a good metal to metal contact. No ground wires smaller than No. 8 shall be used, and all wires larger than No. 8 shall be bare copper cable.

## 3.0 Transformers

In specifying transformers for specific installations, consideration should be given to service continuity, voltage regulation, overall efficiency, system flexibility, safety and costs of operation and maintenance, as well as to initial investment.

Use of transformers in electrical systems permits distribution at relatively high voltages and transforming to utilization voltage at load centers. Typical distribution voltages are 13, 800, 4160 and 2400 volts.

Substations located near load centers provide for short runs at utilization voltages with improved voltage regulation.

Two developments have greatly expanded the range of practical application of transformers in interior wiring systems:

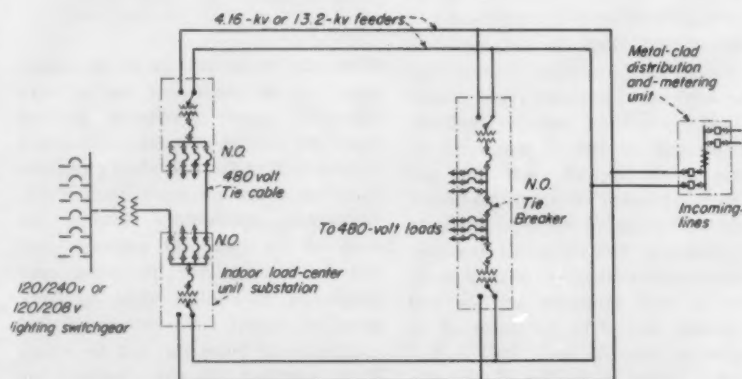
a. The metal-clad unit power center or substation; a combination of transformers and switchgear fully self contained and protected and designed for free standing installation in industrial plants and large buildings without vault protection.

b. Dry type distribution transform-

ers which require no special enclosures and may be installed in practically any indoor location.

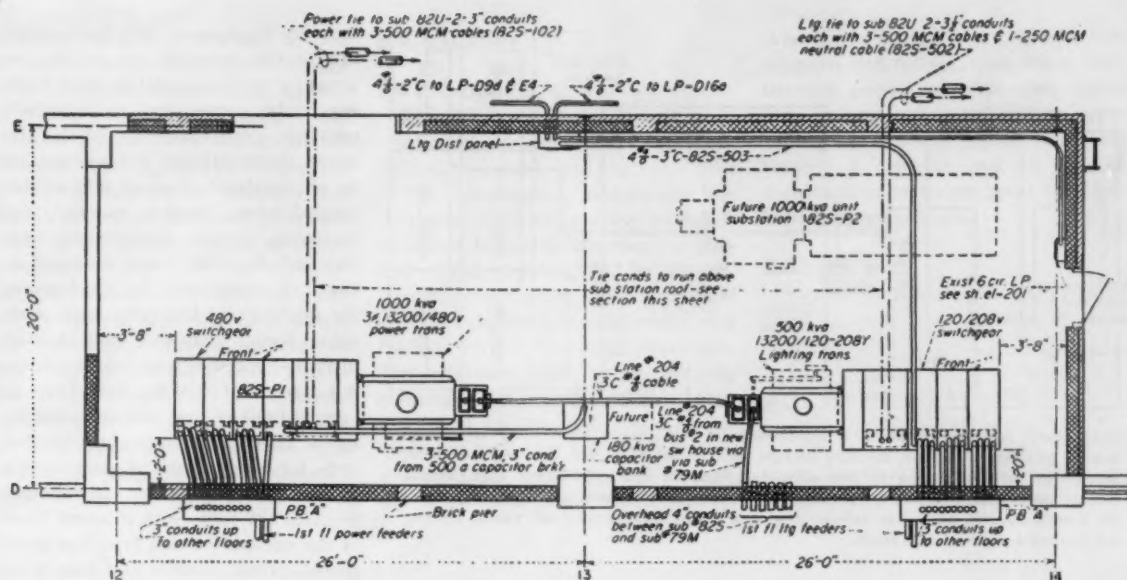
Individual dry type transformers of the general purpose type (120/240 volts) are most frequently used for industrial applications for taking lighting or special appliance loads from power circuits of 240, 480, or 600 volts. Normal ratings run from 1½-

kva to about 500-kva. Their advantages are being recognized by more and more users of power, for they can operate close to load centers, require little attention, minimize distribution losses, eliminate the need for separate low-voltage power circuits, provide power for small motors at a lower utility rate, reduce copper costs and improve voltage regulation.



Selective systems for power distribution, while slightly more expensive to install than radial systems, give far greater reliability via dual feeders and secondary ties.





Vault layout for a manufacturing plant shows two substations; a 1000-kva unit for power and a 500-kva unit for lighting. Space is provided for the addition of extra units if future load growth demands it.

In locating a dry type transformer, thought should be given to accessibility, ease of inspection, surrounding structural conditions and prevailing humidity. Since these units depend upon the surrounding air for cooling, clean, dry air is essential to provide adequate ventilation and, whenever possible, filtered air should be recommended. Surrounding air should be such that the average ambient temperature does not exceed 85° F. Transformers should be so located that water cannot fall on the case, also, dusty atmospheres, corrosive liquids and gasses must be absent. To permit free air circulation, dry type transformers must be separated from one another by from 1 to 3 feet, depending on their size and, also, they must be separated from walls and partitions.

Because their noise level is higher than liquid-filled transformers, dry type units should not be installed in places where the noise would be objectionable.

Small dry type transformers can be specified for either single-phase or 3-phase use. In general, single-phase units are less expensive and more adaptable, but three-phase units are used when 3-phase 208-volt power is required for the operation of small motors. Single-phase units are connected line-to-line on a 460-volt system, and arranged for 120/240 3-wire single-phase on the secondary.

Three-phase units are connected delta on the 460-volt side and 208Y/120-volt 3-phase 4-wire on the secondary side. With voltage taps now available in the primary windings of dry type units, these units can be used to deliver almost exact voltage requirements.

Installation design details must conform to the National Electrical Code and local or state regulations. They must also meet the approval of the power supply company.

The transformer specification frequently is contained in a single paragraph or group of clauses, or they may be specified in a numbered or itemized related series of statements. Either way, however, their designation, installation, location and connection should be explicit, and a complete specification could cover any or all of the following detailed information. Examples of typical clauses are shown in boldface type.

### 3.1 Application

Intended use, purpose, relation to other sections of the system.

#### 3.11 Main transformer.

Utility primary service stepped directly to desired utilization level, as in a simple radial distribution system.

#### 3.12 Master station.

Supplied by primary service conductors, with secondaries in turn sup-

plying two or more transformer substations located in various parts of the customer's premises.

**Master station shall be designed for (outdoor or indoor) installation. It shall consist of transforming and coordinating combinations of high-voltage and low-voltage switchgear, installed in accordance with the feeder diagram and at the location shown on the plans.**

#### 3.13 Load center substation.

Where in-plant distribution voltage is stepped to utilization level near center of utilization area.

#### 3.14 Local transformer.

For specific application; located as close as possible to that item or application, such as lighting installation, individual motor or group of machines, bus structure for small tools, etc.

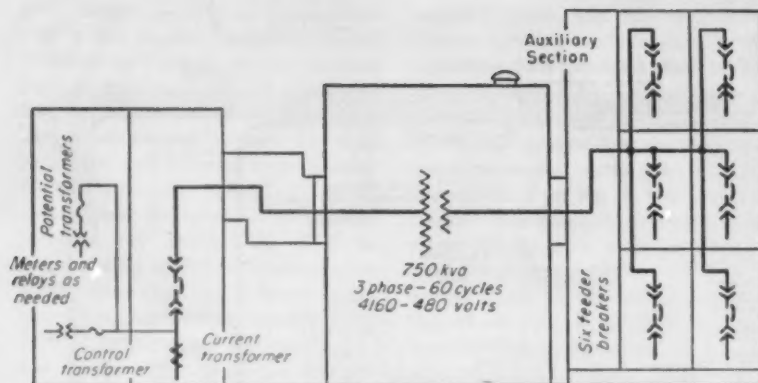
#### 3.15 Special transformers.

For applications other than normal power, lighting and heating; such as X-ray and high-frequency use, low voltage for remote control or signal systems, electric furnaces, electric discharge lighting, hazardous locations, current transformers, etc.

### 3.2 Characteristics

#### 3.21 Name-plate data.

Rated kva, frequency, primary and secondary voltages, percent taps, man-



Load center substation contains a transformer (in this case a liquid-filled unit), high voltage switchgear and an auxiliary section with circuit breakers. Use of load center substations permits placing of unit close to saturation center of power requirements, reduces copper requirements for primary distribution feeders, shortens lengths of secondary branch circuits, minimizes voltage drop and boosts efficiency of all power, lighting and heating equipment as a result.

manufacturer, serial number, style, form, polarity, impedance.

### 3.21 Characteristics.

Transformer shall be rated for —/— kva, oil insulated (or Askarel filled, or air cooled, etc.), 3-phase 60-cycles, — volts delta primary, — volts wye secondary, with solidly grounded neutral. High voltage windings shall be provided with 2½% taps, two above and two below normal, externally operated manual tap changer handle arranged for padlocking in each position. Taps may be changed only when transformer is de-energized. They provide means for adjusting to average supply voltage. Automatic tap-changing equipment for operation under load shall be installed on low voltage side to maintain constant voltage on low-voltage terminals (or some point on the feeder).

### 3.22 Wet.

(Insulating liquid; oil, Askarel) or dry types (air cooled; natural convection, fan forced) or sealed.

## 3.3 Construction

### 3.31 Switches.

Primary and secondary disconnecting mediums, connections for parallel operation (secondary ties).

### 3.32 Bus structure.

### 3.33 Enclosure.

Gas-oil sealed tank shall be equipped with drain and sampling valves, filter press connections, magnetic oil gauge with alarm contacts,

relief diaphragm, ground block and top-oil dial type thermometer. It shall also have nameplate, delta-wye terminal board, neutral bushing, provision for future addition of automatically controlled fans to give continuous overload rating of — kva.

### 3.34 Related instruments.

Voltage transformation section shall include contact-making voltmeter, line-drop compensator and necessary auxiliary control mounted on a hinged steel panel within the unit substation. A rotary switch for selecting automatic or manual control shall be provided. Current transformer for line-drop compensator will have 0.2-amp secondary and be located under oil in the transformer. Potential for the contact-making voltmeter shall be obtained from a potential transformer in the switchgear, and power to drive the mechanism obtained from the switchgear control power transformer. An operation counter and position indicator shall be included. Reactance portion of the line-drop compensator shall be provided with a reversing switch for parallel operation with other units.

### 3.35 Related sections.

Incoming line section, outgoing feeder section.

Incoming high voltage circuit connections shall consist of a 3-pole 2-position (open-close) disconnecting switch and pothead with uncut wiping sleeve arranged for bottom connections. This switch shall be key interlocked with the feeder circuit breaker to prevent it from interrupting load

current. Equipment shall have — kva interrupting capacity at — kv, — amps (or it shall consist of cover bushings with connectors; or externally operable gang-operated switch. Include characteristics and ratings, oil or air insulated, load or magnetizing current break, fused or unfused, etc.) Incoming circuit connections shall also include strain frame mounted on cover of transformer for dead-ending the high-voltage incoming lines. Outgoing feeder switching section shall include—potential transformers, drawout type— /120 volts, with fuses of current-limiting type (for reclosing relay of transformer secondary breaker and load-ratio control equipment); Pyranol control power transformer —/115/230 volts with drawout fuses of the current-limiting type (for main power circuit breaker and load ratio control equipment); 115-volt 250-watt heater, and light switch, light outlet and convenience outlet receptacle. Outgoing feeder section shall also include oilless circuit breaker, vertical lift, — amps, —kva interrupting capacity, 220 volts ac rectifier solenoid operated, necessary auxiliary switches, latch checking switch, control relay, over-current relays, reverse-power relays, etc. Breaker shall be complete with mechanical interlocks, primary and secondary disconnecting devices. Low voltage feeder switchgear shall consist of — radially connected circuit breakers, — volts, — amp interrupting capacity, manually operated, drawout type, mounted in dead-front steel hinged-front compartments with removable rear plates, copper buses and provision for bolting to other sections in the field to form an integral unit. Drawout low-voltage breakers shall be equipped with safety interlocks to prevent withdrawal or insertion of breakers when they are in the closed position, manual trip buttons, external visual indicators showing breaker position, arc quenchers and insulated closing handle for manual operation.

### 3.36 Details of accessories.

Bushing, core and coil details.

High voltage bushings shall be stud (pothead, wiping sleeve, etc.) type, cover (or sidewall) mounted. Low voltage bushings shall be stud (etc.) type, cover mounted. All bushings shall have suitable gaskets to provide a tight fit. Individual high-voltage and low-voltage coils shall be wound on separately formed barriers in order to

facilitate removal of the coils in case of repairs being required. Windings shall consist of copper coils suitably insulated, thoroughly dried and vacuum treated. Core shall be manufactured of high-grade non-aging sheet-steel laminations, properly annealed, treated and insulated from each other in accordance with approved practice.

These transformers shall be guaranteed against load and total losses, and the limiting dimensions and net and shipping weights, also the regulation at 100% and 80% power factor shall be given. Testing shall conform to ASA transformer standards, and units must meet all ASA acceptance tests.

### 3.4 Location

#### 3.41 Outdoor.

(Pole mounted, roof, fenced, concrete pad, external wall brackets, housed, protected, etc.)

The main outdoor transformer station shall include a complete packaged 6-column switching structure for control of the incoming 115-kv circuits. It will have spacing, clearances and mechanical details in conformity with NEMA Power Switching Standards. The structure shall be of hot dip galvanized steel, completely shop fabricated with column and trusses assembled, and including bolts for erection, mounting and anchoring; station luminaires, control cable within station.

Also to be included are 115-kv bus supports and fittings, connectors, conductors, strain, and grounding materials to interconnect the station apparatus. The outdoor station shall also include a concrete pad to support transformers and switchgear (per following specifications).

#### 3.42 Indoor.

(Vault, platform or balcony, basement, interior walls, column or truss brackets.)

#### 3.43 Details of housing.

Also mounting (vault construction, ventilation, drainage, access, type of door, foundation channels, bolting arrangements, service facilities).

## 4.0 Circuit Switching and Protection

Circuit switching and protection is provided for in the specifications by descriptions of the various equipments usually supplemented by the riser diagram and detail drawings.

Circuit switching and protection starts at the service entrance and are provided at each division of the electrical system through to the branch circuits.

For service entrances served by networks and serving high capacity, low impedance systems, consideration must be given to the interrupting capacity of the switchgear to be used. A precise analysis of the system impedance and the available short circuit or fault currents should be made whenever the interrupting capacity of conventional equipment is likely to be exceeded under any possible conditions of failure, accident or malfunction. The following types of service entrance equipment are widely used:

a. Individual enclosed externally operable switch and fuse or a group of enclosed fused switches.

b. Individual enclosed circuit breaker or a group of enclosed circuit breakers.

c. Assemblies of fused switches in a single enclosure.

d. Assemblies of circuit breakers in a single enclosure.

e. Totally enclosed metal clad switchgear.

Service entrance equipment may be installed separately or in combination

with distribution panelboards or switchboards.

Distribution and branch circuit panelboards should be described giving the number and capacity of main busbars, main switch and main overcurrent devices, number of branches of each capacity and number of poles and type of switch, fuse or circuit breaker desired.

#### 4.1 Service Entrance Switches

Service entrance switches shall be furnished and installed as shown and described in the plans and riser diagram. Switches shall be rated and approved as suitable for use as service equipment.

Enclosures shall be of suitable material and design for the surrounding conditions.

Fuse types shall be so interlocked with the external switch handle that the door cannot be opened except when the switch is in the "off" position and that the switch cannot be placed in the "on" position except when the door giving access to fuses is closed. Further, when this door is open no uninsulated live metal terminal or other live metal parts shall be readily accessible.

Service entrance breakers: The service entrance switch shown shall be of the enclosed circuit breaker type. Breaker shall be manually operated, trip free and designed so that all

poles open simultaneously. Overload tripping mechanism shall be (thermally operated, magnetically operated) and arranged to provide effective sealing against tampering.

#### 4.2 Panelboards

##### 4.21 Fused.

Furnish and install as shown on plans and indicated in the riser diagram distribution and branch circuit panelboards equipped with switches and fuses of the capacities noted.

Panelboards shall be dead front and enclosed in a code gauge steel box. Trim shall be flush or surface type as shown. Doors shall be equipped with spring latches. (Indicate whether locks are required and whether locks should be identical for all panels.)

The mains of panelboards shall be furnished with lugs only unless otherwise indicated.

Panelboards shall be of standard types and the product of established manufacturers. The capacity of switches and fuses shall be as shown. Each circuit shall be provided with fuses in all poles except neutral.

Pull out type switches shall be dead front when closed and fuses shall be dead in the open position. Branch circuit panels shall be dead front with switches and fuses. Switches shall be heavy duty tumbler type.

a. Distribution panels shall be unit construction dead front safety type.



Switches shall be steel enclosed with switch blade assembly mounted on a hinged cover. Opening of hinge cover shall automatically open the switch unit.

b. Distribution panels shall be unit construction dead front safety type. Switches shall be quick make and quick break, in steel enclosed unit with external operating handle.

c. Distribution panels shall be unit construction dead front with pull-out type fusible circuits. Fuses shall be inaccessible until completely cleared from contact with the mains. Units shall have provisions for testing fuses.

**4.22 With circuit breakers.**

Branch circuit panelboards shall be the dead front safety type equipped with circuit breakers. Bus bars shall have lug connections for attaching feeders and arranged for—wire mains and — wire branches, unless otherwise noted on drawings. The grounded side of each branch circuit shall be fed direct from the neutral bus bar. The circuit breaker shall control the ungrounded conductor(s).

Distribution panelboards shall be of the dead front safety type equipped with circuit breakers. Bus bars shall have lug connections for attaching feeders. The sizes of circuit breakers shall be as noted on drawings and unless otherwise noted shall be double pole for 3-wire single-phase or 3-pole, for 4-wire, 3-phase 208-volt circuit breakers, with the neutral connected to common bus bar.

Circuit breakers shall be of the (thermal, thermal-magnetic, hydraulic-magnetic) type.

### 4.3 Switchboard

Switchboard shall be the dead front safety type consisting of panels and circuit breakers of the number and sizes shown on the drawings. The construction shall consist of a structural or formed steel frame carefully built into a rigid structure which shall maintain its alignment and not be damaged in shipment or erection or by stresses resulting from short circuits. The frame shall be completely enclosed on front and sides with sheet steel plates. Adequate ventilation shall be provided. A pull box of the same type of construction shall be provided at the top of each switchboard which shall match the switchboard in dimension and finish. Bottom of pull box shall be non-combusti-

ble insulating material and cables to circuit breaker studs dropped vertically through individual openings in bottom to their respective studs. Switchboard shall be sectionalized to permit access to the breakers.

Buses on switchboard shall be of hard drawn copper of 98% conductivity. Connections shall be bolted and laminations interleaved to secure maximum contact areas. All buses and circuit breaker stub connections shall be of such size as to limit the temperature rise to 30° C. when carrying full-load current at room temperature, but not to exceed a current density of 1000 amperes per square inch.

### 4.4 Cabinets

All cabinets shall be made of sheet steel. Cabinets for panelboards shall provide proper space for all wires and connections.

Cabinets for telephone terminal strips and connection points shall be of sizes and depths noted on plans.

Cabinets shall be of standard make and shall bear the manufacturer's name plate or stamp and the Underwriter's Laboratories' inspection label.

Fronts for flush cabinets shall consist of sheet steel frame and a hinged door with catch and lock. Frame shall be about ¼ inch larger than cabinet on all sides and shall be set with its back flush with the finished wall.

Telephone and signal cabinets for surface mounting shall be equipped with a door hinged directly to cabinet. Door shall be made of one piece of sheet steel and shall have a ¼ inch flange around all edges shaped to cover edge of box and equipped with catch and lock.

Lighting and power cabinets for surface mounting shall be equipped with a sheet steel frame and hinged door with catch and lock. Frame shall be the same size as cabinet and shall completely cover wiring gutter.

Each cabinet shall be furnished with a catch and flat key lock. All locks shall be fitted to the same key. Furnish keys for each job.

All cabinets shall have proper means for securing, supporting, and adjusting the panelboards and fronts. Cabinets shall be arranged to provide a wiring gutter not less than 3 inches wide for panelboards up to 31 inches high and not less than 4 inches wide for larger panelboards.

Lighting and power cabinets shall be installed with tops 6-ft 6-inches above floor, and telephone cabinets shall have bottom just above baseboard. Telephone and signal cabinets in ground floor shall be installed with tops 6-feet 6-inches above floor, unless otherwise noted on drawings. Those in finished spaces shall be set flush in walls and those on unfinished walls or where shown on drawings shall be set exposed. All cabinets shall be rigidly secured in place. All cabinets shall have fronts straight and plumb and arranged so that panelboards will be centered in door opening. Telephone cabinets over 30 inches wide shall have double doors.

### 4.5 Fuses

Protective devices for circuits not over 125 volts to ground and not over 30-amp capacity shall be of the plug type and shall be of such a type and so designed as to be subject to tampering or bridging only with difficulty.

a. Fuses shall be one time, standard type.

b. Fuses shall be of the time delay type; capable of holding 200% load for 10 seconds.

Plug fuses installed in residential occupancies shall be of the time delay type.

All other circuits shall be protected by cartridge fuses (one time, renewable)

Fuses shall be of the correct capacity to protect the circuits as shown and for the voltage specified.

a. Of standard type, accurately rated.

b. Time delay type.

Spares amounting to one-half of a duplicate set of those installed shall be turned over to the owner upon completion of the work.

Use of time delay fuses should be considered for circuits serving motor, appliance or other services subject to momentary or variable loads of relatively short duration.

For loads above 600 amperes to 5000 amperes and for very high interrupting capacity below 600 amperes consideration should be given to the use of high-interrupting-capacity fuses employing silver links in a chemically inert filler. These fuses are of special design and are bolted in place. Short circuit arcs tend to fuse the inert material, quickly dissipate the energy, and block the flow of current.



## 5.0 FEEDERS

Feeders of modern electrical distribution systems can be divided into two classifications: primary (at high voltage) from the main switchroom to the unit substations; and secondary (at utilization voltages) from the unit substations to the branch circuit distribution panels. The introduction of primary distribution to in-plant electrical system design has led to more economical installations on long one-story industrial structures and tall multi-story commercial buildings. The long high voltage feeders to electrical load centers require substantially less conductor copper. The resultant shorter secondary feeder lengths cut voltage drop loss, reduce secondary conductor sizes and result in more economical operating costs.

In general, primary in-plant distribution voltages range from 2,400 volts to 13,800 volts. Typical spe-

cification clauses for feeders might include any or all items on the following check-list indexing system, and then would be detailed in accordance with the typical clauses here presented in boldface type.

### 5.1 Classification

#### 5.11 Primary feeders.

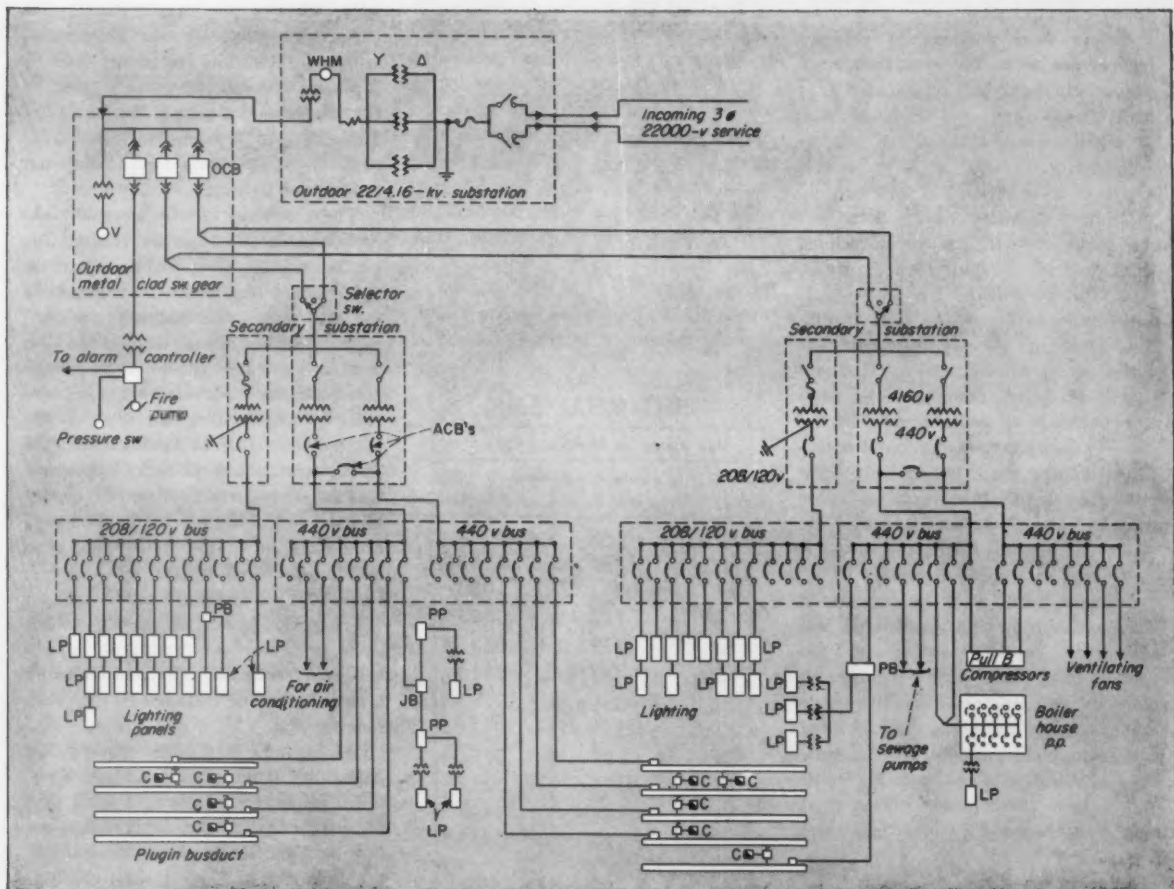
The electrical contractor shall furnish and install a complete primary feeder system from the primary switchroom to all unit substations shown on the plans and indicated on the riser diagram. Conductors shall be enclosed in rigid steel conduit raceways installed overhead (or underground) as noted on the plans. System shall be \_\_\_\_\_ volts, 3-phase, 3-wire.

Conductors for overhead circuits

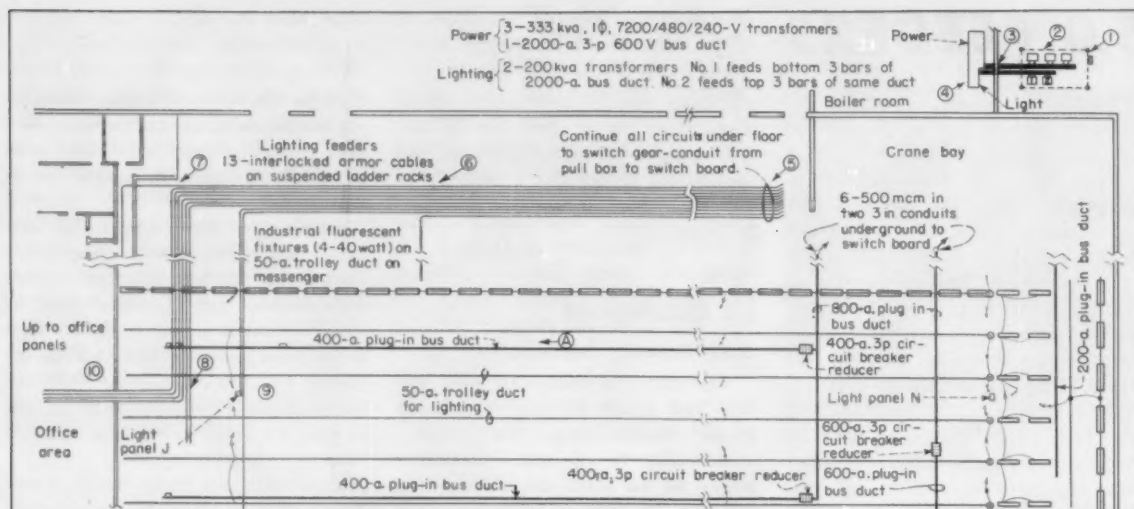
shall be No. \_\_\_\_\_, single-conductor (or multi-conductor) cables with \_\_\_\_\_ type insulation rated at \_\_\_\_\_ volts as noted. Conduit sizes shall be as indicated.

Conductors for underground circuits shall be No. \_\_\_\_\_, single-conductor (or multi-conductor) cables with \_\_\_\_\_ type insulation rated at \_\_\_\_\_ volts as noted. Conduits shall be of sizes indicated and shall be installed not less than \_\_\_\_\_ inches below grade. Conduits shall be enclosed in a concrete envelope not less than \_\_\_\_\_ inches thick.

Conductors for direct burial, where noted on plans, shall be No. \_\_\_\_\_, single-conductor (or multi conductor) cables with \_\_\_\_\_ moistureproof insulation rated at \_\_\_\_\_ volts. Cables shall be installed not less than \_\_\_\_\_ inches below grade in a sand envelope and with suitable mechanical protec-



Dual primary feeders with selector switches serve secondary substations which in turn feed power and lighting distribution buses. Detailed drawings like this present a clear picture of complete electrical distribution system.



A variety of wiring methods may be used for electrical distribution. Here, in a single small plant, bus duct, underground conduit and cable, overhead interlocked armor cables and trolley duct provide an unusual degree of electrical flexibility.

tion over cables under roadways and driveways.

All conductors shall bear Underwriters' label and shall be as manufactured by the \_\_\_\_\_ Company, or approved equivalent.

Where riser portions of primary feeders are accessible to unauthorized personnel, they shall be encased in a concrete envelope \_\_\_\_\_ inches thick, or other approved means of protection, for a distance of \_\_\_\_\_ feet above floor level.

Primary feeders, where noted on the plans and in the specifications, shall be of the interlocked armor type. Cables shall be No. \_\_\_\_\_, 3-conductor, with \_\_\_\_\_ type insulation rated at \_\_\_\_\_ volts and encased in an interlocked spiral metal armor of (steel, aluminum, bronze). Cable shall be as manufactured by the \_\_\_\_\_ Company, or approved equal. These cables shall be suitably supported by ladder-type racks or cable troughs as manufactured by the \_\_\_\_\_ Company and the \_\_\_\_\_ Company, or approved equal.

Primary cables shall be terminated with potheads having the voltage and conductor capacity rating of the cables used, or other termination methods recommended by the cable manufacturer. Potheads shall be filled with compound suitable for the voltages specified. Do not heat the compound to a temperature higher than that recommended by the manufacturer.

All primary cable splices shall be made with an approved splice for the cable installed and of a type recom-

mended by the cable manufacturer. Splices shall be made by mechanics specially trained in this operation.

## 5.12 Secondary feeders.

Detailed information covering lighting and power feeders should be given in plans and specifications, preferably in the riser diagram or tabular listing of feeders. Such information should include point of origin and termination of feeder, conduit size, cable size, number of cables per feeder, type of cable insulation, number and size of pull boxes in each run, sizes and types of lugs or connectors at terminations and tap-off locations, method of supporting feeders and routing details. It is good practice to

give a general description of the secondary feeder system, as designed for the specific project, and then add specification clauses covering individual components of the complete system as required.

Secondary electrical distribution within the building (or plant) shall be 3-phase, 440-volt, 60-cycle, 3-wire, ac for power and 3-phase, 4-wire, 120/208-volt for lighting (or 480/277-volt, 3-phase, 4-wire for combined power and lighting).

The electrical contractor shall furnish and install separate feeders for power and lighting from the main switchboard (or unit substations) to the various distribution cabinets, panels and switches throughout the area as shown in the plans and indicated on the riser diagram. Feeders shall be of the sizes and types as indicated and shall be installed in steel conduits mounted on racks supported by hangers secured to structural beams and slabs. Cable supports in riser conduits shall be of the split-wedge type as manufactured by the \_\_\_\_\_ Company, or approved equivalent.

Wherever practical, feeder cables shall be continuous without splices between terminals. All conductors of a circuit shall be installed in the same raceway.

Where field conditions require any deviations from plans and specifications, all suggested changes shall first be checked with the supervising authorities and with other mechanical trades to avoid unnecessary conflict. The electrical contractor must secure written approval of the supervising

## SHEET METAL GAUGE

USG Gauge for Sheet and Plate Steel

Gauge No.	Thickness of Steel in Inches	
	Uncoated Sheets	Galvanized Sheets
8	.1644	.1681
10	.1345	.1382
12	.1046	.1083
14	.0747	.0785
16	.0598	.0635
18	.0478	.0516
20	.0359	.0396
22	.0299	.0336
24	.0239	.0276
26	.0179	.0217
28	.0149	.0187
30	.0120	.0157

Note: Due to variation in manufacture, a plus or minus tolerance of approximately 10 percent is generally recognized and allowed by some authorities.

authorities before making such changes.

### 5.13 Routing.

### 5.14 Sizes and insulation.

### 5.15 Terminals and splices.

## 5.2 Design Factors

### 5.21 Current carrying capacity.

Every feeder and subfeeder shall have a carrying capacity at least sufficient for the current corresponding to the maximum demand of the electrical loads indicated on the plans. Follow the recommended demand factors listed in the current NEC Feeder Demand Factor Table and provisions of Section 2203.

Determine the standard load for general illumination from the unit load per square foot in watts and the area of the space to be illuminated. Add to this load 1,000 watts for each circuit specified herein for purposes other than general illumination and 1,000 watts for each spare panelboard circuit, and any specific other load not otherwise included.

### 5.22 Voltage drop.

The allowable current-carrying capacities of insulated conductors listed in Table 1 of the current National Electrical Code are based on temperature ratings alone and do not take into consideration voltage drop. Feeder capacities should be computed on the basis of load served and the length of the feeder run to secure minimum voltage drop.

Feeders and subfeeders shall be of such size that, at a load corresponding to the maximum computed demand, the total voltage drop from the service entrance (or unit substation cubicles) to any branch circuit panelboard will not exceed 1.5%.

### 5.23 Spare capacity.

Good engineering practice demands that feeder systems include a substantial measure of spare capacity to accommodate future electrical system expansion. In general, inclusion of such spare capacity in the original system design will be less costly than adding it at a later date. This can be accomplished in the following manner:

1. Oversizing the original feeders to handle the estimated additional future load. When this is done, the feeder size should be large enough to accommodate the combined present

and anticipated future load and still maintain a maximum of 1.5% voltage drop. This method is recommended where the maximum conductor size, to meet the above conditions, does not exceed No. 4.

2. Installing oversize raceways so that original conductors can be withdrawn and replaced by larger cables when electrical expansion demands additional feeder capacity.

3. Including in the original design provisions for future installation of additional feeder capacity at a minimum of expense.

In all cases, provision should be made at the feeder distribution centers (main switchboard or unit substation) for control and protection of the additional feeder capacity without expensive remodeling of the original equipment. Generally, this means having sufficient substation bus capacity to handle the addition of future switches or circuit breakers and space provision for easy installation of such equipment when needed. Every feeder should be protected by a fuse or circuit breaker.

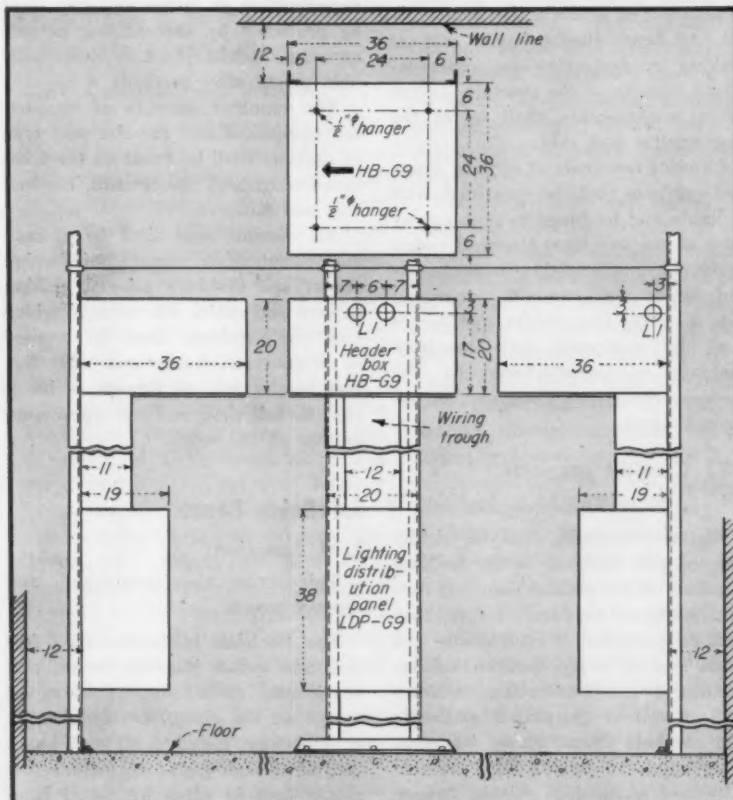
When the system design calls for future addition of supplemental feeders, suitable openings should be provided in walls, floors, etc., during original construction, for such future feeder circuits.

## 5.3 Conduits

### 5.31 Conduit construction.

Threads, dimensions, elbows, finish.

All conductors shall be installed in hot dipped galvanized rigid steel conduit (or aluminum) and galvanized flexible steel conduit of sizes indicated on the plans and as specified hereinafter. Steel conduit shall be manufactured of mild steel tube of uniform thickness with a smooth circular bore and thoroughly welded seams to permit cutting of clean, true threads. The pitch and shape of threads shall conform to the American Standard pipe thread; taper shall be constant and continuous for the total thread length. Each length of conduit, including factory-made elbows, shall be threaded on both ends.



Detailed dimensional drawings of arrangement of wiring troughs, pull boxes, cabinets and panels in limited spaces eliminate considerable confusion and simplify installation.



Internal finish, enameling and outside treatment shall be smooth, hard and flexible.

Where conduit is noted on plans or mentioned in the specifications, it shall be hot-dipped galvanized or sherardized heavy-wall conduit as manufactured by the \_\_\_\_\_ Company, or approved equal.

### 5.32 Cutting.

Joints, terminals.

Ends of conduit shall be cut square with hand or power saw or approved pipe cutter. Cut ends shall be reamed to remove burrs and sharp edges. Threads cut on conduit in the field shall have the same effective length and the same thread dimensions and taper as specified for factory cut conduit threads. Conduits installed contrary to these requirements shall be removed and replaced.

Conduit joints shall be made with approved couplings and unions. Right angle bends, offsets and change-in-direction bends shall be made with hickey or power bends, standard elbows and offsets, conduit fittings, or pull boxes as specified and indicated on the plans. Conduit runs shall be straight and true; elbows, offsets and bends shall be uniform and symmetrical. All bends shall be made without kinking or destroying the cross-sectional contour of the conduit. Installation workmanship shall be of the best quality and skill.

Conduit terminals at outlets, boxes and cabinets shall be provided with locknuts and bushings as required by the national and local electrical codes. Ends of conduits of 1 1/4-in. trade size and larger and conduits containing No. 4 AWG size cables and larger shall be equipped with insulated bushings as manufactured by the \_\_\_\_\_ Company, or approved equal.

### 5.33 Conduit supports.

Hangers, clamps, bolts, brackets.

Exposed conduits shall be rigidly and securely fastened to the building structure on not greater than 5-ft centers. Hangers, supports or fastenings shall be provided at each elbow and at the end of every straight run terminating at a box or cabinet. Clamps shall consist of galvanized malleable iron one-hole straps, clamp backs or other approved device with suitable bolts and expansion shields (where needed) for mounting to building structure or special brackets. Adjusta-

## CABLE SUPPORT SPACING IN VERTICAL RACEWAYS

Conductor Size	Maximum Space Between Supports—in Feet
No. 18 to No. 1/0	100
No. 2/0 to No. 4/0	80
250MCM to 350MCM	60
350MCM to 500MCM	50
500MCM to 750MCM	40
Above 750 MCM	35

ble hangers on larger conduits separately located may be used to suspend horizontal runs.

If trapeze hangers are used for parallel runs of conduits, U-bolts shall be used at the end of each run at each elbow. J-bolts shall be installed on each third intermediate hanger to securely fasten each conduit in the group. Hangers shall have an adjustable feature to keep all conduits in perfect alignment.

Hangers shall be fabricated from durable materials suitable for the condition involved and shall be painted two coats of lead and oil paint. Where hangers are subject to atmospheric or other conditions likely to cause deterioration or corrosion, they shall be protected by sherardizing or galvanizing, special paint or other suitable preservative methods.

The required strength of supporting equipment and the size and type of anchors shall be based on the combined weights of the conduit, conductors and hangers.

All conduit runs shall be cleaned and swabbed to remove all foreign matter and moisture prior to pulling in wire and cable. All boxes in which conduits terminate shall be cleaned of all concrete, mortar and other foreign matter and all threads in boxes shall be left clean and true upon completion of the work.

### 5.4 Cable Boxes

#### 5.41 Junction.

This clause also covers pull and support boxes.

The electrical contractor shall furnish and install junction boxes, pull boxes and cable support boxes as shown on the plans, specified herein, or otherwise required. These boxes shall be of Code gauge steel with screw covers held in place by round head silicon bronze machine screws. Boxes shall be secured in position indepen-

dently of conduits entering them by means of bolts, rod hangers, brackets or other suitable methods. All boxes shall be treated or painted to resist corrosion.

Cable support boxes made of No. \_\_\_\_\_ gauge steel shall be installed in the riser shafts at levels indicated on the plans. Boxes shall be no less than \_\_\_\_\_ inches high; wide enough and deep enough to provide ample working room to install cable wedges in riser conduits; shall be reinforced with heavy angle-iron frames; and shall have removable screw covers secured with brass machine screws.

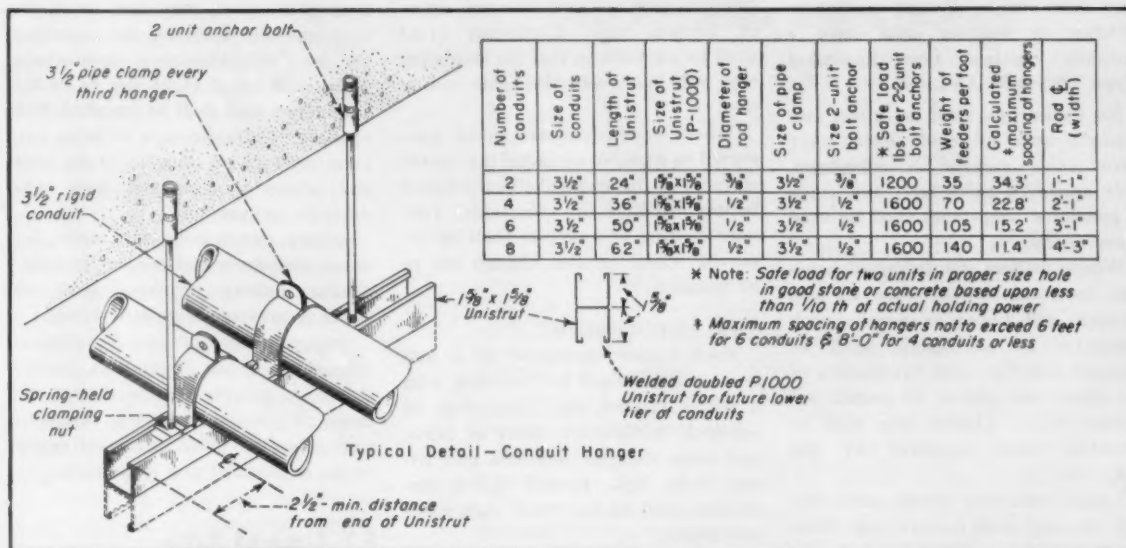
Conduits entering the cable support boxes shall be provided with two-bolt clamp-type conduit support brackets at each floor level installed to support conduit risers without adding strain to cable support boxes.

Pull boxes, fabricated from No. \_\_\_\_\_ gauge sheet steel on angle-iron frame shall be furnished and installed where indicated on the plans and wherever they shall be necessary to facilitate the pulling or splicing of feeder cables. In general, boxes shall be installed on all conduit runs exceeding 100 feet in length. Access shall be by means of screw covers secured by silicon bronze machine screws. Boxes shall be of a size to provide ample pulling and slicing space and shall be constructed from approved detailed drawings. Boxes shall have close-tolerance openings for conduit entrance and shall have suitable insulated cross-brackets to support feeder cables every three feet. Feeders passing through boxes shall be identified by fireproof tags or by other approved means. Cables of each circuit shall be bound together with cabling twine. Steel barriers between circuits shall be provided in the pull boxes where indicated or where considered necessary. All boxes shall be supported from the building structure independent of the conduits entering them. There shall be no unused openings left in the boxes when the project is completed.

#### 5.42 Wedges and clamps.

Cable supports shall be of the double wedge type and of a size to fit the conduits and cables in the riser feeders. Supports shall be as manufactured by the \_\_\_\_\_ Company, or approved equivalent. The supports shall clamp each individual conductor firmly and tighten due to cable weight.





Good hanger design for feeder conduits incorporates rigid support features and provision for additional conduits. Detailed schedule of component dimensions simplifies field assembly.

## 5.5 Accessible Wireway

### 5.51 Mesh cable troughs.

Furnish and install expanded metal cable troughs, where indicated on the plans, to house and support feeder conductors. Cable trough shall be made of flattened expanded metal, formed to a channel shape bent on a radius of not more than 1/4-in. The standing sides shall be trimmed with a binding edge of No. 16 gauge steel, spot welded at regular intervals along the length of the trough. Standard trough lengths shall be eight feet. Trough and fitting widths shall be of standardized dimensions to permit future extensions and expansion using stock parts. The complete cable trough system, with its fittings, shall permit easy field assembly even when trough lengths have to be cut on the job site. The trough system shall permit change of direction, elevation, and branch circuit taps through use of standard fittings. All trough sections and fittings shall be so designed that there will be no sharp edges or projections to injure cable insulations. Cable troughs and fittings shall be as manufactured by the \_\_\_\_\_

Company, or approved equal.

Where wireways are indicated on the drawings, they shall be an approved type and installed according to the recommendations of the manufacturer, complete with all necessary fittings, connectors and parts. All parts shall be of the same make and shall be assembled accurately and sup-

ported firmly. Wireways shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

### 5.52 Hinged ducts.

### 5.53 Floor trenches.

## 5.6 Cable Specifications

### 5.61 Construction, installation.

Selection of the proper type and size of conductors is one of the most important engineering tasks involved in electrical system design. System and equipment efficiency, economical operation and minimum maintenance depend to a substantial degree on the capacity of the feeder cables. Maximum known load, anticipated future additional loads and voltage drop should be taken into consideration. The quality of insulation surrounding a conductor determines the useful life of the cable. Conductors and cables are available in a number of different insulations to cover a variety of maximum operating temperature ratings. Frequently, substantial installation economies (through higher current ratings) can be made by selecting insulations capable of withstanding higher temperatures—such as Type RH as compared with Type R.

As a general rule, the combination of oversize conductors to allow for future loads plus best quality insulation lead to ultimate economies which offset any small additional initial cost that may develop.

The electrical contractor shall furnish and install all wire and cable of the sizes and types shown on the plans, included in the feeder schedule and noted in the specifications. Unless otherwise specified, all conductors shall be 600-volt, rubber-insulated of the heat-resistant Type RH and shall conform to the latest requirements of the National Electrical Code and meet all ASTM specifications. Conductors shall be thoroughly tinned, soft drawn copper (or aluminum). Braid shall be flameproof.

Except as otherwise noted, wire sizes No. 14 to No. 8 shall be solid. Wire sizes No. 6 and larger shall be stranded, double braid. All sizes called for on the plans and in the specifications shall be American Wire Gauge sizes. Conductors shall be factory color-coded, with a separate color for each phase and neutral used consistently throughout. Note the color coding (green) required by the N.E.C. for conductors intended solely for grounding purposes.

Cables shall be as manufactured by the \_\_\_\_\_ Company, since (month and year), or approved equal. They shall be suitably protected from weather or damage during storage and handling and shall be in first class condition when installed.

Conductors installed in boiler rooms, or runs within three feet of heating pipes shall be Type AVA, impregnated asbestos and varnished cambric insulated.

Conductors installed in basement

floor slabs and in all runs exposed to moisture or weather shall have a moisture resistant type insulation (Type TW, RW, AVL, etc.).

No conductors shall be drawn into conduits until all work which may cause cable damage is completed. Only approved cable lubricants (such as powdered soapstone) shall be used when necessary.

Where feeders consisting of more than one conductor per phase leg pass through pull boxes or panels, each conductor of one phase shall be grouped together with conductors of the other two phases to reduce reactance effect. Limiter lugs shall be provided where required by the N.E.Code.

Unless otherwise noted, each conduit raceway shall contain only those conductors constituting a single feeder circuit.

As far as practicable, all feeder cables shall be continuous from origin to panel termination without running splices in intermediate pull boxes or splicing chambers. Sufficient slack shall be left at the terminations to make proper connections.

The electrical contractor shall furnish and install all hangers, racks, cable cleats and supports required to make a neat and substantial cable installation in cable chambers, splicing chambers, cable pits and other locations as required. Marlin twine shall be used to bind cable groups together where necessary.

All cable terminals, taps and splices shall be made with solderless pressure type connectors, unless otherwise specified. All connections shall be made secure so they will not loosen under vibration and normal strain. Connectors shall be of the type as manufactured by the \_\_\_\_\_ Company, or approved equal, and shall be large enough to enclose all conductor strands.

Where compression type connectors are noted on the plans and in the specifications, they shall be of the type as manufactured by the \_\_\_\_\_

Company, or approved equal, and shall be installed with approved hydraulic tools to assure a permanent high conductivity joint.

Where soldered joints are specified, the cable joint shall be mechanically strong before soldering. Solder shall be carefully applied without use of acid. Soldered connection shall be wrapped with rubber tape to a thickness equal to that of the cable in-

sulation, then covered with two layers of friction tape. Conductor braid shall be cut back so that the insulating tape will bend with the cable insulation.

Where conductors are to be connected to metallic surfaces, the coated surfaces of the metal shall be polished before installing the connector. Lacquer coating of conduits shall be removed where ground clamps are to be installed.

### 5.62 Identification.

Each feeder conductor in a pull box or panel shall be identified with a feeder symbol tag. Tags shall be one-inch in diameter, made of brass, and have stamped numbers and letters 1/4-in. high. Branch circuit conductors shall be identified with adhesive bands.

### 5.63 Aluminum conductors.

Where indicated on the plans, specifications, and feeder schedule, conductors shall be insulated aluminum EC grade, semi-annealed, of quality and physical characteristics specifically designed for installation in interior wiring systems, and approved for the purpose.

Cable insulation shall be Type \_\_\_\_\_ as noted on the plans and listed in the N.E.C. and manufacturers' literature.

Aluminum conductors shall be of the size and type noted on the plans and shall have sufficient capacity to take care of the designed load, future capacity and voltage drop. Note: The National Electrical Code states "allowable current-carrying capacities shall be taken at 84% of those given in the table for the respective sizes of copper conductor with the same type of insulation."

All conductor ends shall be stripped of insulation carefully to avoid nicking the metal. Approved types of oxide inhibiting compounds containing abrasive conducting particles shall be applied to the conductor and shall thoroughly penetrate spaces between strands.

Splices and terminals shall be made expertly in an approved manner and with approved connectors specially designed for use with aluminum conductors.

Where bolted, pressure type connectors are used, they shall be specially designed for use with aluminum conductors and shall be drawn up tight to manufacturers' recommendations.

Where high compression type con-

nectors are used, they shall be of the type specially designed and approved for use with aluminum conductors. They shall be of exact size to fit the conductors and shall be installed with approved hydraulic tools to bring uniform pressure on all sides of the joint and assure a permanent high conductivity connection.

Where connections are made between aluminum and copper (two dissimilar metals), provision shall be made to prevent electrolytic action.

Design considerations: Aluminum conductors in the larger sizes (feeder sizes) are gaining increased recognition. When used in this manner, such cables can effect substantial economies in material and installation.

## 5.7 Armored Cable

### 5.71 Installation.

Describes characteristics, construction, installation, support, terminals, sizes.

The electrical contractor shall furnish and install secondary feeders of the interlocked armor type as indicated on the drawings and feeder Schedule. Cables shall be \_\_\_\_\_ conductor, 600-volt, \_\_\_\_\_ insulation, of sizes indicated, with cable assembly enclosed by a continuous interlocked armor of (steel, aluminum, bronze) as manufactured by the \_\_\_\_\_ Company, or approved equivalent. All splices shall be made in approved fittings or junction boxes with connectors made up tight to provide a firm mechanical and electrical connection.

Cables shall be strapped in place on girders and columns, following structural members closely, or supported by cable troughs or ladder racks as noted on plans or specified. Troughs and racks shall be as manufactured by the \_\_\_\_\_ Company, or approved equal. Where cables cross open areas, they and their supporting racks or troughs shall be suspended by a 3/8-in. steel messenger wire or catenary structure as detailed on the drawings. The electrical contractor shall furnish and install all troughs, racks and brackets necessary to install the feeder runs.

## 5.8 Bus Duct

### 5.81 Construction, characteristics.

Bus duct provides an efficient and

economical method of carrying both small and large blocks of secondary power from transformers to switchgear and from switchgear to motors, lighting systems and other electrical equipment. Composed of insulator-suspended copper bars enclosed in a steel housing, the duct is available in several types and capacities. Feeder duct is available in low-reactance, ventilated type, and weatherproof type, in ratings from 600-amp to 4,000-amp, single-phase, 3-phase, and 3-phase, 4-wire. Steel-enclosed distribution type bus duct with easily accessible plug-in type openings is available in ratings from 225-amp to 1,500-amp, 600 volts. Duct is factory fabricated and assembled; comes in 10-foot sections for installation ease; provides flexibility and convenience; is completely salvable and can be easily re-installed when necessary to meet production layout changes. A typical specification for such a system follows:

The electrical contractor shall furnish and install a complete system of interconnected bus duct runs of the feeder type of the phase and ampere ratings as indicated on the plans in the riser diagram.

Duct runs are to be assembled from standardized sections so fabricated that the complete system shall be rigid in construction and neat and symmetrical in appearance.

Bus bars shall be fabricated from best grade 98% conductivity pure copper or aluminum. (Also specify type of plating contact surfaces.)

Interconnection of adjacent casing ends and bus bars shall be made by means of neatly fitted scarf-lap joints. All joints or splices in bus bars shall be made with standard bolted connections which will maintain high contact pressure.

Suitable hand holes with removable covers shall be provided at the joint on both sides of each duct section to permit accessibility and ease of connection.

All duct sections shall be provided with standard hangers as indicated on the plans. All rods, straps, special brackets and other approved methods of suspending duct hangers shall be furnished and installed by the electrical contractor.

Feeder duct construction shall be listed by the Underwriters Laboratories and all sections shall be so labeled.

Where used outdoors, feeder bus

duct shall be of the same general construction with the addition of a weatherproof finish on the casing and an additional wrapping of weatherproof insulating tape on the bus bars. Duct so used shall be approved as "suitable for use outdoors."

Where the bus duct system is used for distribution to electrical equipment, the duct sections shall be provided with plug-in openings to accommodate current take-off devices.

No less than ten current take-off or plug-in openings shall be provided for each 10-ft duct section. These openings shall be designed to insure proper polarization of the plugs with respect to bus bars.

Current take-off devices or plugs shall be of approved design.

Plugs shall be of ample capacity for the respective circuits served.

The complete bus duct system shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

## 5.82 Installation, accessibility.

## 5.83 Accessory fittings.

## 5.9 Underground

### 5.91 Cables.

Number, characteristics, sizes, voltage.

### 5.92 Routing.

Clause includes trenches, ducts or conduit, manholes.

Underground distribution circuits

## 1953 CODE FEEDER DEMAND FACTORS

Type of Occupancy	Unit Load Per Sq. Ft. (Watts)	Load to which Demand Factor Applies (Watts)	Demand Factor
Armories and Auditoriums	1	Total Wattage	100%
Banks	2	Total Wattage	100%
Barber Shops and Beauty Parlors	3	Total Wattage	100%
Churches	1	Total Wattage	100%
Clubs	2*	Total Wattage	100%
Court Rooms	2	Total Wattage	100%
Dwellings — (other than Hotels)	3*	3,000 or less Next 117,000 Over 120,000	35% 25%
Garages — Commercial (storage)	1/2	Total Wattage	100%
Hospitals	2	50,000 or less Over 50,000	40%* 20%
Hotels, including apartment houses without provisions for cooking by tenants	2*	20,000 or less Next 80,000 Over 100,000	50%* 40% 30%
Industrial Commercial (Loft) Buildings	2	Total Wattage	100%
Lodge Rooms	1 1/2	Total Wattage	100%
Office Buildings	2	30,000 or less Over 30,000	100% 70%
Restaurants	2	Total Wattage	100%
Schools	3	Total Wattage	100%
Stores	3	Total Wattage	100%
Warehouses, Storage	1/4	12,500 or less Over 12,500	100% 50%

In any of above occupancies except single-family dwellings and individual apartments of multi-family dwellings:

Assembly Halls and Auditoriums	1	Total Wattage as specified
Halls, Corridors, Closets	1/2	for the specific occupancy
Storage Spaces	1/4	

(See Section 2203-C — 1953 NEC)

\*For sub-feeders to areas in hospitals and hotels where entire lighting is likely to be used at one time; as in operating rooms, ballrooms, dining rooms, etc., a demand factor of 100% shall be used.



must be given special considerations based on the type of installation, soil conditions, possibility of damage to cables and restrictions or allowances set up by local practice. All underground systems should be shown clearly on the plot plan with notations as to voltage, cable type and size, type and size of duct or duct assembly, and precautions to take against mechanical damage at specific locations. Detailed drawings of duct entrances at manholes and equipment terminations as well as cross-sections of duct banks should be included. Specific attention should be paid to including and noting spare raceways or ducts. Places where direct burial cable is to be installed should be noted on the plans. In general, runs should be direct and straight between manholes and terminal points, clear of roadways and crossings and separated from other underground systems, particularly those requiring occasional maintenance or repair.

The electrical contractor shall furnish all services and furnish and install all materials and equipment for the complete underground feeder system as outlined on the plans and specifications. He shall be responsible for excavating, draining trenches, form-

ing of duct assembly and concrete envelope, backfilling and removal of excess earth.

All cables shall be installed in asbestos-cement (or steel or fiber) conduits of diameters and number specified or indicated on the plans and detailed in duct bank cross-sectional drawings.

All ducts shall be installed below the normal frost line, at least — inches below grade. Ducts containing cables operating above 600 volts shall be installed at least 30 in. below grade.

Trenches and duct lines shall be graded so that ducts will have a fall of at least three in. per 100 ft from buildings or section high points toward manholes. Provision shall be made in manholes for drainage of water and moisture accumulation.

Conduits containing high voltage cables shall be encased in a concrete envelope with not less than 3-in. of concrete beyond any conduit surface. Banked conduits shall be held securely in place, at not less than 2-in. spacing between conduits, by approved separators. Concrete shall be a 1-3-4 mixture.

The concrete envelope shall be reinforced at all points where duct lines cross fill or loose soil, water, gas or

sewage mains, or pass under roads or traffic drives. Reinforcement shall consist of one ¾-in. steel reinforcing rod between each two ducts in bottom layer and one rod at each corner of the envelope. Rods shall be parallel to conduits, centered between conduits and between conduits and bottom of concrete encasement. Reinforcing shall extend four feet beyond area in which such protection is needed.

Fiber or asbestos-cement conduits shall be mandrilled to insure a smooth interior wall free from burrs or obstructions. Conduits shall terminate in end bells at building and manhole walls. The electrical contractor shall install and leave a No. 8 B and S galvanized steel drag wire in all empty spare conduits.

Where direct-burial cable feeders are noted on the plans, such cables shall be laid in the trench on a 3-in. cushion of sand and covered with 3-in. of sand to prevent cable damage from rocks or sharp objects in the fill. At specific places noted on drawings, or specified herein, creosoted planks shall be placed over the sand fill on top of the cables.

#### 5.93 Direct burial.

#### 5.94 Installation, protection.

## 6.0 Branch Circuits

### 6.1 General Considerations

#### 6.11 Capacities, voltages.

Branch circuit design and installation should receive the same careful consideration as feeders. Ample conductor capacity to take care of known electrical loads, anticipated future loads and voltage drop should be installed. Electrical loads should be shown on the plans and noted in the specification. If definite loads cannot be determined, estimated loads should be indicated. In all cases, loads should be equally balanced on all phases of the branch circuit system. Circuits may be of the single-phase, 2-wire; single-phase, 3-wire; or 3-phase, 4-wire type at voltages provided by the secondary distribution system. Type and voltage of all branch circuits should be clearly indicated. It is good engineering practice to show detailed circuiting where unusual conditions exist.

#### 6.12 Special provisions.

One example of careful branch circuit consideration is the special wiring required to supply tenants in office buildings using metered electric current. Wiring for this purpose must be so designed that groups of circuits are available for tenant's use through one meter irrespective of the number of rooms occupied by that specific tenant.

The use of wall receptacle outlets properly placed as conduit junction boxes offers a good solution to this problem. These receptacles should be so placed that they will not be concealed by either present or future room partitions. Such boxes are tied together by ¾-in. conduit runs and can be used for extensions to both present and future room outlets. Boxes intended for such use should be the 4½-in. square type with plaster cover to within ¼-in. of wall surface.

#### 6.13 Wiring methods.

The plans and specifications should clearly indicate the wiring method or methods to be used for branch circuit installations, as well as clear cut specifications for conductors, wiring materials and devices. Detailed installation requirements of approved wiring methods will be found in the current edition of the National Electrical Code. Choice of wiring systems is often limited by local ordinances and rules. Such rules should be considered.

Methods commonly employed for branch circuit wiring include the following:

- a. Rigid steel (or aluminum) conduit
- b. Electrical metallic tubing
- c. Armored cable
- d. Non-metallic sheathed cable
- e. Mineral-insulated cable
- f. Open and concealed porcelain protected wiring (knob and tube)



- g. Busways
- h. Wireways
- i. Underfloor duct
- j. Cellular metal floors

Typical specification clauses for branch circuit wiring components will appear later in this section. These should be added to the general specification covering the branch circuit system.

The electrical contractor shall furnish and install all raceways (as noted) and conductors (of type noted) and wiring devices, fittings, and supporting facilities for all branch circuit systems as indicated on the plans and in the specifications. Equipment shall conform to requirements as outlined in specific paragraphs contained in these specifications.

All branch circuits shall be installed as shown on the floor plans. Minimum size wire shall be No. 12, type — insulation, 600 volts, except as otherwise noted on the plans for special system circuits. Larger sizes shall be used where indicated, or where required by voltage drop or other design considerations.

Outlets shall be located approximately as shown on the plans and shall be properly centered where located in panelled work or other special interior finish.

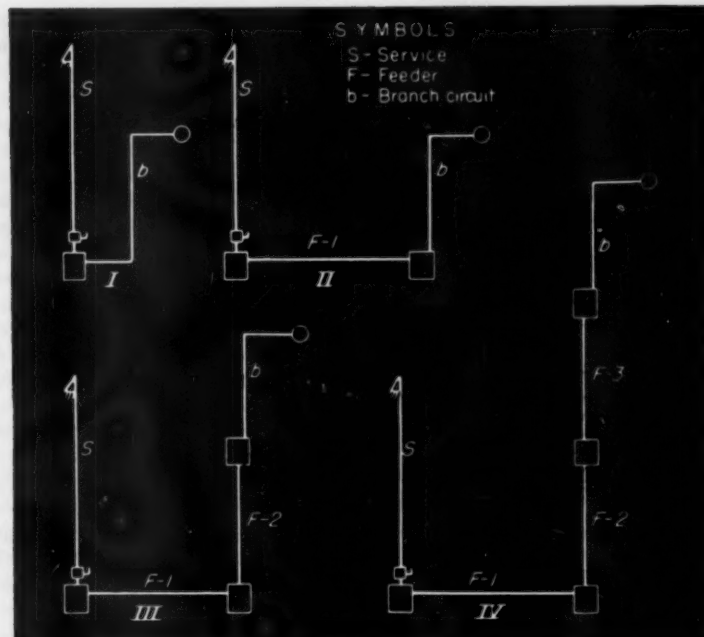
Wall switches of 10-amp, 125-volt rating shall be installed as shown on the plans and shall be connected to provide the control of outlets indicated. They shall be "T" rated for Type "C" lamp loads.

Receptacles shall be the standard flush duplex type rated 15-amp at 125 volts, adapted to receive standard 2-prong plugs; 2-circuit type where indicated; 3-wire grounding type where indicated; or multi-outlet assemblies as noted on the plans.

Conductors terminating at each wired outlet shall be left not less than 8 in. long at their outlet fitting to facilitate the installation of devices or fixtures. Where two or more pairs of conductors or circuits enter an outlet, the several pairs or circuits shall be neatly spliced and made mechanically and electrically secure to one or more single or multiple conductors.

## 6.2 Lighting Circuits

The minimum number of branch circuits required for general illumination should be based upon the standard loads.



EXAMPLE	ALLOWANCES FOR VOLTAGE DROP									
	S	F-1	F-2	F-3	b	TOTAL DROP				
	SERVICE	FEEDER SECT 1	FEEDER SECT 2	FEEDER SECT 3	BRANCH CIRCUIT	SERV TO OUT				
	3W 120/240V	3W 120/240V	3W 120/240V	3W 120/240V	3W 120/240V	120 V				
	% OF 240V	% OF 240V	% OF 240V	% OF 240V	% OF 120V	% OF 120V	% OF 120V	% OF 120V	% OF 120V	% OF 120V
I	2.0 4.8	—	—	—	10 12	30	3.6			
II	1.0 2.4	10 2.4	—	—	10 12	30	3.6			
III	0.75 1.8	0.75 1.8	0.5 1.2	—	10 12	30	3.6			
IV	0.5 1.2	0.5 1.2	0.5 1.2	0.5 1.2	10 12	30	3.6			

Guide to distribution of voltage drop loss over the electrical system from service entrance to utilization outlet.

For 2-wire 15-amp circuits, the load per circuit should not exceed 1,000 watts.

For multi-wire 15-amp circuits, the load should not exceed 1,000 watts between each outside wire of the circuit and the neutral wire.

For heavy-duty circuits, the maximum load per circuit depends upon the smallest size of wire used in the circuit and should be 1,500 watts for No. 10 and 3,000 watts for No. 8 or No. 6.

## 6.21 General lighting.

Branch circuit conductors shall be installed in specified raceways to outlets indicated on the drawings.

No wire smaller than No. 12 shall be used for any lighting branch circuit. If the single distance from panelboard to first outlet exceeds 50 ft, the minimum size of wire for this run shall be No. 10 and the minimum size between outlets shall be No. 12. Panelboards shall be so located that no run

from the panelboard to the first outlet will exceed 100 ft. If, in special cases, this distance must be exceeded, the loads should be reduced or the wire sizes increased to provide for a voltage drop not exceeding 2% at the last outlet. This applies to both 2-wire circuits and multi-wire circuits.

## 6.22 Show windows.

Branch circuit wiring shall be installed to outlets for show window lighting, the circuit capacities to be based upon the wattage specified. Where wattage is not indicated, a load of not less than 200 watts per lineal foot of show window, measured horizontally along its base, should be used to determine circuit capacity (NEC Section 2116-c-2).

## 6.23 Case lighting.

Branch circuit wiring shall be installed to outlets for show case and wall case lighting, the circuit capacities to be based upon the wattage

specified and the actual or probable lengths to be lighted.

### 6.24 Receptacle circuits.

No convenience outlets shall be supplied by any 2-wire circuit, or by any outside wire of a multi-wire circuit, that supplies one or more outlets for general illumination, show window general lighting, show window spot lighting or case lighting. Outlets for show window spot or floodlighting and convenience outlets in or near the floor in show window spaces shall be separately controlled.

No wire smaller than No. 12 shall be used for any circuit supplying convenience outlets. Runs exceeding 100 ft in length from the panelboard to the first outlet should be avoided whenever practicable. If unavoidable, such runs shall be not smaller than No. 10 wire and the wire between outlets shall not be smaller than No. 12 conductor.

## 6.3 Power Circuits

Complete branch power wiring for motors, heating and power apparatus shall be installed in accordance with the accompanying wiring diagram. Raceways and conductor sizes shall be as noted on the plans.

If no detail diagram is used the following may be included in the specifications.

### 6.31 Individual circuits.

Each motor shall be supplied by an individual branch circuit from a distribution center. Conductors shall not be smaller than the minimum sizes permitted by the National Electrical Code and shall be of such size that the voltage drop from the distribution center to the motor will in no case exceed 1% when the motor is carrying its rated full load. Feeder conductors shall be of at least such size that the voltage drop from the service equipment to any distribution center will not exceed 3% when all motors are operating at their rated full load.

On exceptionally long motor circuits, such as roof vent fans fed from basement panels, the voltage drop of the circuit due to starting current of the motor should not be greater than 10%. A better practice is to feed such motors from nearby panels and operate by remote control circuits.

### 6.32 Subfeeders.

Motors shall be supplied through

group subfeeders from distribution centers. Subfeeders shall either be brought direct to motor starters (or disconnecting means) or shall be connected to starters (or disconnecting means) by means of tap conductors. Subfeeders shall be of at least such size that when all motors are operating at full load the voltage drop from the distribution center to any motor starter will not exceed 2%. Feeders from service equipment to distribution centers shall be of at least such size that when all motors are operating at full load the voltage drop from the service equipment to any distribution center will not exceed 3%.

### 6.33 Bus duct taps.

Motors shall be supplied by individual taps from the bus bar distribution system. Taps or bus plugs shall be provided with (disconnect switch, fuses, circuit breakers, etc. as required). Circuit shall be extended from bus plug to controller in (conduit, flexible conduit, armored cable, heavy duty bus drop cable, etc.) not to exceed 25 ft in length. Circuit shall be installed so that conductors and terminal connections will not be damaged by machine vibration.

The electrical contractor shall furnish and install all motor starters, push button control stations, disconnect switches, thermal protective devices and fuses. Where motor starters are an integral part of a machine the electrical contractor shall furnish and install thermal protective devices and fuses for such units.

## 6.4 Wiring Mediums

### 6.41 Conduit.

For all conduit work as called for elsewhere in these specifications or shown on the plans, furnish and install (select one or more types and state where each type shall be used):

- a. Galvanized rigid steel conduit,
- b. Corrosion resistive, non-ferrous alloy rigid conduit,
- c. Flexible metallic conduit.

Conduits shall be of sizes required to accommodate the number of conductors in accordance with the tables given in the current edition of National Electrical Code or as noted on drawings. The minimum size of conduit shall be 3/4-in. Joints shall be cut square, reamed smooth and drawn up tight.

Concealed conduits shall be run in

as direct a line and with as long bends as possible. Exposed conduits shall be run parallel to or at right angles to the lines of the building. All bends shall be made with standard conduit elbows, conduit bent to not less than the same radius or hub type conduit fittings. All bends and offsets shall be free from dents or flattening. Not more than the equivalent of four quarter bends shall be used in any run between terminals at cabinets, outlets, and junction or pull boxes. All boxes shall be located in accessible locations.

Conduits shall be continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes, and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from point of service to all outlets. Terminals of all conduits shall be furnished with locknuts and bushings. Plug the ends of each conduit with an approved cap or disc to prevent the entrance of foreign materials during construction.

So far as practicable, all exposed conduits shall be run without traps. Where dips are unavoidable, a pull box shall be placed at each low point or a hole drilled in under side of conduit to drain any moisture accumulation. Conduit systems shall be completed before conductors are drawn in. Where conduits must be run exposed, except as indicated in the plans, location of the runs shall be subject to approval.

All conduit runs shall be securely supported by — straps, or — hangers, or supporting assemblies as indicated on the plans.

All conduit, elbows, and couplings shall be as manufactured by the — Company, or approved equal.

All conduit fittings, as indicated on the plans, shall be of a type as manufactured by the — Company, or approved equal.

Considerations: On concealed conduit installations, exposed runs are usually installed where concealing would weaken structural features, slabs are too thin for size of conduit needed, or where installation can be made in unfinished spaces.

### 6.42 EMT.

Electrical metallic tubing raceways as called for in the specifications and shown on the plans shall be approved type as manufactured by —

Company, or approved equal. Couplings and connectors shall be of the threadless type as manufactured by the Company, or approved equal. All connectors shall be made up tight. If tubing is installed in wet locations, or buried in masonry, concrete, or fill, couplings and connectors shall be of a watertight type.

#### 6.43 Armored cable.

For all armored cable wiring as called for elsewhere in these specifications or shown on plans furnish and install approved armored cable properly bushed at ends and securely fastened to outlet boxes with approved connectors. Armored cable shall be of the best quality designed to offer a low resistance grounding path. Wires entering outlet boxes shall be not less than 8 inches long before stripping for joints or connections to devices. Armored cable shall be as manufactured by \_\_\_\_\_, or approved equal.

#### 6.44 Non-metallic sheath.

For all non-metallic sheath cable branch circuits as called for elsewhere in these specifications, and as

noted on the plans, furnish and install the indicated sizes of non-metallic sheath cable of the \_\_\_\_\_ type, with \_\_\_\_\_ insulation, as manufactured by the \_\_\_\_\_ Company, or approved equal. The cable shall be approved for the type of service and installation conditions noted. Cable shall be supported every 4½ ft by \_\_\_\_\_ type straps or staples approved for the purpose.

Where cable is to be installed in wet or corrosive atmosphere, cable shall be Type NMC (moisture and corrosion resistant).

Where branch circuit cable is shown underground (direct burial), cable shall be Type UF with Type RW, TW, RUW, or RHW insulated conductors and an overall outer covering which shall be flame-retardant, moisture-resistant, fungus-resistant and corrosive-resistant.

#### 6.45 Mineral-insulated cable.

Branch circuit conductors in the \_\_\_\_\_ areas, where indicated on the plans, shall be of the mineral-insulated, metal-sheathed type as manufactured by the \_\_\_\_\_ Company, or approved equal. Cable shall be (one, two, three, etc.) con-

ductor with a highly compressed refractory mineral insulation (magnesium oxide) encased in a continuous metal (copper) sheath. Cable shall be installed in strict accordance with manufacturer's instructions.

Cable shall be supported, at not more than 6-ft intervals, by means of approved staples, straps, hangers, or other fittings, to building structure or specially designed brackets.

At termination points, cable shall be provided with an approved seal immediately after stripping to prevent entrance of moisture into the mineral insulation. Conductors beyond the sheath shall be encased in approved insulating sleeve.

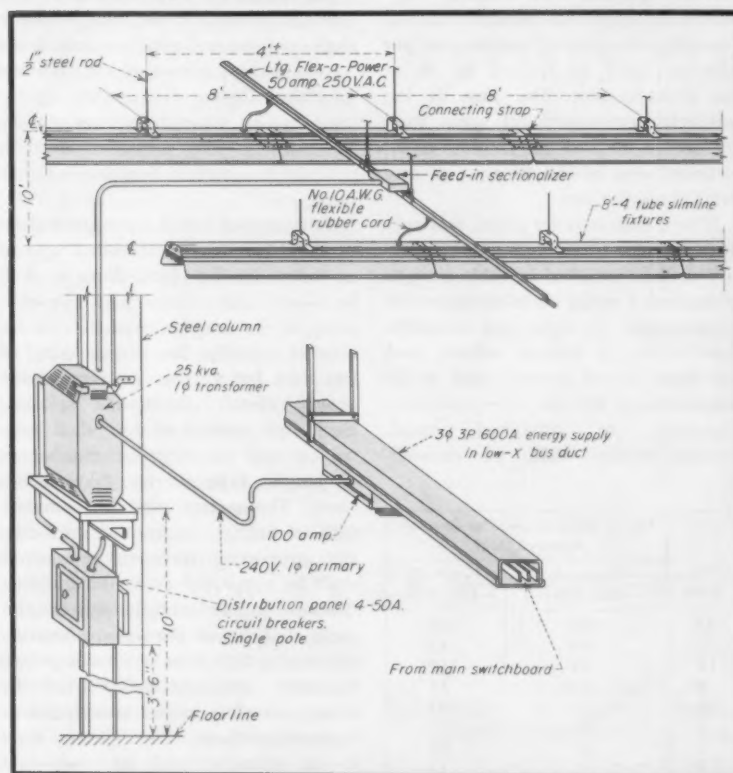
When MI cable is connected to outlet boxes, panels, or other equipment, approved fittings suitable for the service conditions shall be used. Fittings shall be of the threaded-gland type with "screw-on pot" seals filled with an insulating compound approved for the atmospheric and service conditions in which the cable is used. Fittings shall be as manufactured by the \_\_\_\_\_ Company, or approved equal, and shall bear an Underwriters' label of approval.

Stripping of cable ends, installation of fittings, application of insulating compound, and actual cable terminations shall be made according to manufacturer's specific instructions.

Mineral-insulated cable has conductors of high conductivity copper meeting ASTM specifications B4 or B5. The conductors are finely divided, highly compressed, magnesium oxide powder insulation are encased in a continuous seamless copper tubing. Cable has a 600-volt rating with a maximum continuous working temperature of 250° C. (482° F.). Current-carrying capacity is listed as being limited only by the safe operating temperature of the sheath, terminating arrangements and voltage drop.

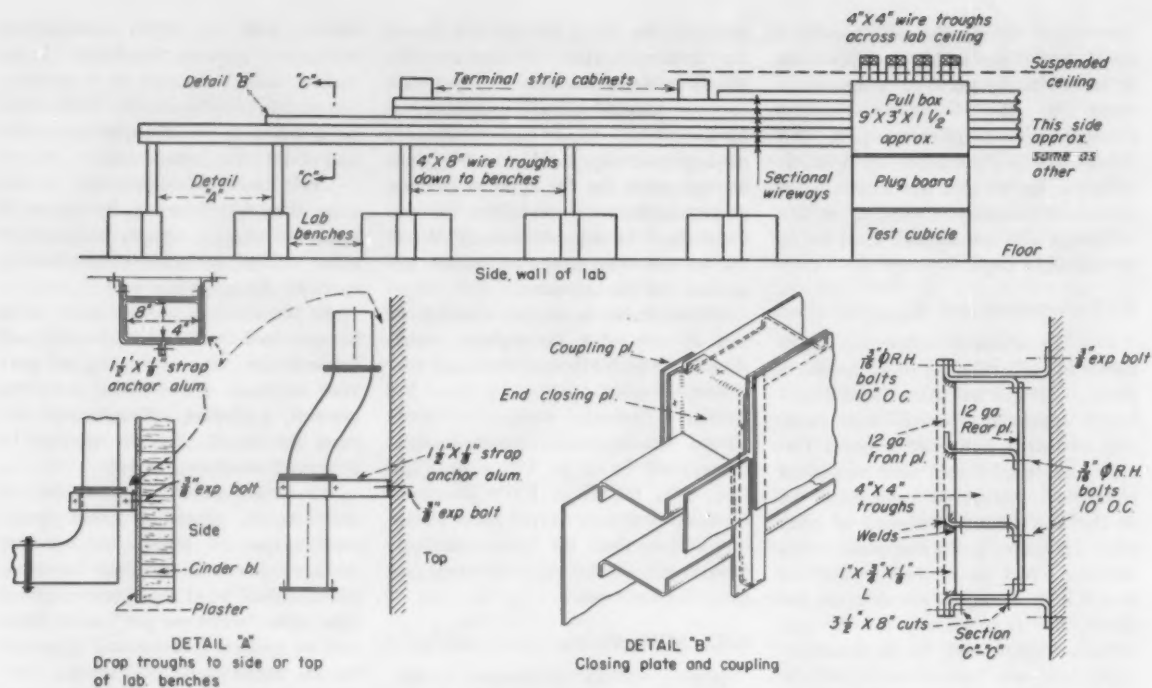
MI cable may be used for services, feeders and branch circuits in both exposed and concealed work, in dry or wet locations, exposed to weather or continuous moisture, for underground runs and embedded in masonry, concrete or fill, or where exposed to oil, gasoline and other conditions not having a deteriorating effect on the metal sheath.

Where MI cable is installed in hazardous locations, it is recommended that local inspection authorities be consulted to be certain that the



Trolley duct lighting branch circuits are fed from power bus duct run through single-phase transformer. Fixtures supported independently of duct.





Wireways of standard or special design simplify distribution of multiple branch or control circuits involving large numbers of conductors.

proper terminal fittings and insulating compound approved for existing use conditions are installed.

#### 6.46 Open wiring.

For all open wiring or knob-and-tube work as called for elsewhere in these specifications, furnish and install non-combustible, non-absorptive insulating bushings, cleats, knobs and tubes as manufactured by the \_\_\_\_\_

Company, or approved equal, and flexible non-metallic tubing as manufactured by \_\_\_\_\_

Company, or approved equal. Conductors shall be of size indicated and shall have \_\_\_\_\_ type insulation. They shall be supported at intervals not exceeding 4½ ft. Non-metallic outlet boxes as manufactured by the \_\_\_\_\_ Company, or approved equal, may be used with this type of wiring system.

#### 6.47 Wireways and Troughs.

Furnish and install wireways, complete with necessary fittings, to house branch circuit conductors as noted on the plans and called for elsewhere in these specifications. The cross-sectional dimensions of the wireways shall be \_\_\_\_\_ in. by \_\_\_\_\_ in. Covers and knockouts shall be provided in accordance with manufacturer's details. Wireways and fittings

shall be as manufactured by the \_\_\_\_\_, or approved equal.

Wireways shall be securely supported by approved methods at 5-ft intervals. Number of conductors per wireway shall be limited to 30 at any cross-section. The sum of the conductor cross-sectional areas shall not exceed 20% of the interior cross-sectional area of the wireway at any point along the run.

Where indicated on plans, and specified herein, branch circuit conductors shall be installed in cable troughs of expanded metal or other approved construction. Troughs and complete complement of fittings, offsets, and individual circuit outlets, shall be as manufactured by the \_\_\_\_\_ Company, or approved equal. Trough system shall be securely

mounted to or suspended from the building structure.

Maximum size and number of conductors installed in the trough system shall conform to limitations established by the current edition of the National Electrical Code.

#### 6.48 Busways.

(Plug-in, mobile contact, multi-outlet.)

Furnish and install a complete plug-in type bus duct distribution system as shown on the plans. Busway shall be \_\_\_\_\_ volt, \_\_\_\_\_ phase, \_\_\_\_\_ pole, of the ampere capacities as indicated (specify the ampere size of bus duct for various sections of the branch circuit distribution system). Each 10-ft section of duct shall have ten covered openings for attachment of plug-in type current take-off devices. The system shall be complete with all fittings, enclosures, insulating and supporting members as shown; shall be supported from the building structure at 5-ft intervals. System and parts shall be of the same manufacture and designed to be used together. Assembly and installation shall be made according to the manufacturer's recommendations. The system shall be as manufactured by \_\_\_\_\_ Company or approved equal.

Installation should be detailed on

Size Awg	No. of Wires in 40 Per Cent of Header Duct	
	Types R, RH, RW	Types T, TW, RU
14	109	185
12	90	145
10	54	112
8	33	61
6	20	31
4	16	23
3	14	20
2	12	17
1	9	12
0	8	11



the plans and all bus capacities, taps and fittings noted. Specifications may include gauge of metal, dimensions of copper bars, type of insulation, facilities for tap connections and methods of attachment to building structure. Unless the bus duct system is made up of standard lengths and fittings, a manufacturer's detailed dimensional drawing for the complete system should be secured and approved before the equipment is installed. It is not advisable to cut duct sections to fit structural requirements at field locations.

Furnish and install bus plugs as listed and at the locations shown on the plans. Bus plugs shall be of the type and size designated and shall be of the same manufacture as the bus duct and designed for use with it. (Specify disconnect, over-current protection, capacity and type of raceway or cable connection required.)

Connections from the plug-in device to the equipment served shall be made with \_\_\_\_\_ (specify wire and conduit; flexible metallic conduit; or heavy-duty, multi-conductor, bus drop cable). Terminations at motor control cabinets shall be so made that machine vibration will not loosen the mechanical and electrical connections.

Where indicated on the plans, and noted in the specifications, furnish and install capacitor plugs (state kva rating), transformer plugs (state kva rating), ground detector plugs, temperature indicating plugs, transposition sections, and expansion joints.

When bus duct is used on underground systems, a potentializer plug should be installed to establish a definite potential to ground.

Plug-in type distribution bus duct is available in ratings from 225 amps to 1,350 amps, in 2-pole, 3-pole and 3-phase, 4-wire construction. It provides an exceptionally flexible and reusable, high current, branch circuit system where frequent tap-offs to motors, lighting circuits and other electrical loads are necessary.

For installations where contacts are continuous, the following clause would apply.

Furnish and install a complete busway system, as indicated and detailed on the plans, for operation of mobile current-collecting devices. Busway shall be \_\_\_\_\_ amp, \_\_\_\_\_ phase, \_\_\_\_\_ pole, \_\_\_\_\_ volts. System shall be complete with necessary curved busway sections, drop-out sections for insertion and removal of

trolley-type current collecting devices, cable feed-in facilities, end closures and bumpers, and approved hangers. All parts shall be of the same manufacture and designed to be used together. Assembly and installation shall be made according to manufacturer's recommendations. System shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

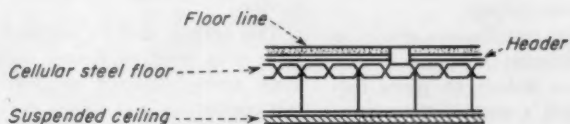
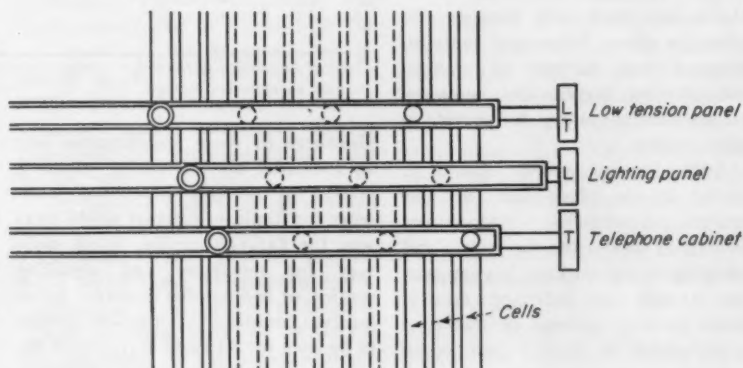
Furnish and install a total of (state number) current-collecting trolleys. Trolleys shall be \_\_\_\_\_ amp, \_\_\_\_\_ phase, (fused or unfused), with (sliding disc, brush, or roller) contacts and equipped (with or without tool hangers). Units shall be designed for use with the busway and provide continuous electrical contact as they move freely along the entire length of the busway.

Furnish and install a single-phase, trolley-type busway system to provide

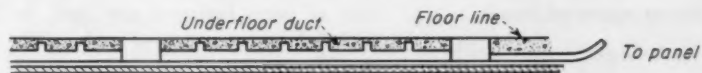
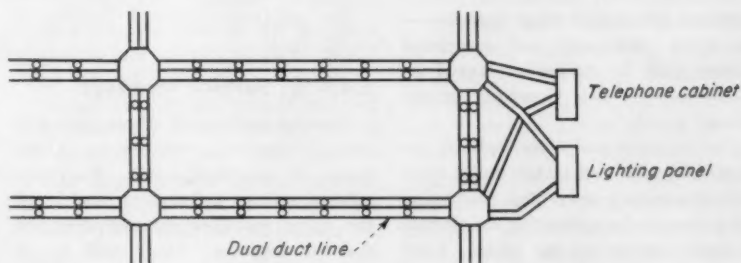
branch circuit wiring for lighting fixtures as indicated on the plans and noted elsewhere in these specifications. Busway shall be \_\_\_\_\_ amp, 2-pole, \_\_\_\_\_ volts, and shall provide continuous electrical contact for mobile, or stationary type (twist-type) current-collecting devices as noted. System shall be complete with necessary fittings, couplings, feed-in devices and current take-off units. Duct runs shall be (flush, messenger cable, rod hanger) mounted and supported by approved hanger fittings at 5-ft intervals, unless closer spacing is indicated on the plans or noted in the specifications.

All fixtures shall be electrically fed and mechanically suspended from the busway with approved weight supports so that suspension is independent of current tap-off device.

Furnish and install a total of (number) current tap-units of the (twist-



Cellular Steel Floor Distribution System



Underfloor Duct Distribution System

Two typical methods of underfloor branch circuit systems are the cellular steel floor (top) and underfloor duct (bottom) for conventional concrete slab construction.

type or trolley) type as noted on the plans and listed in these specifications. Current take-off units shall be of the (terminal or receptacle) type as noted. Busway, tap-off units and accessories shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

Where noted on plans, furnish and install a complete messenger cable system to support the busways. Exact location of messenger cable runs shall be determined in the field. Cable shall be  $\frac{3}{8}$ -in. diameter, high strength, \_\_\_\_\_ strand, galvanized steel wire. Where messenger bridles are used, they shall be of  $\frac{3}{8}$ -in. diameter galvanized flexible steel wire. Cables shall be securely anchored to building steel with end-brackets as detailed on the drawings. Intermediate supports from roof steel structure, and wherever necessary, shall be made of  $\frac{3}{8}$ -in. diameter bolt rod supported by beam clamps. Maximum cable sag allowable is one inch with busway and fixtures in place. Messenger cable installation shall include all clamps, bolts, clevises, turnbuckles, supports, and anchors necessary to provide a secure system.

Mobile busway systems should be detailed on the plans with full and accurate dimensional information. Methods of supporting the system and circuiting to the various busway sections should be indicated clearly. Mobile busway systems of this type in ratings of 50 to 500 amp, come in standard 10-ft sections (plus 5-ft sections in lower rating).

Multi-outlet installations may be specified as follows:

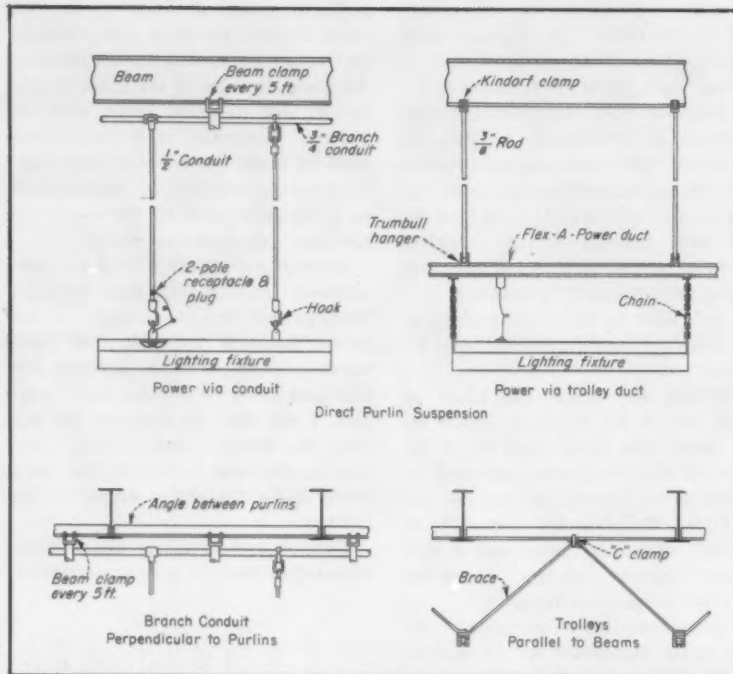
At locations shown on plans furnish and install a multi-outlet assembly in one or more continuous sections. These sections shall consist of a raceway with outlets to receive standard attachment plugs spaced \_\_\_\_\_ in. apart. Raceway and associated outlets shall be as manufactured by \_\_\_\_\_ Company or approved equal.

For window and cove lighting reflectors furnish and install metal raceway or wireway assemblies containing lamp receptacles connected on circuits as indicated on wiring plans. They shall be as manufactured by \_\_\_\_\_ Company or approved equal.

#### 6.49 Raceways.

(Including baseboard, surface, metal framing.)

Furnish and install, as called for



Typical suspension methods for lighting circuits in conduit or trolley duct. Messenger cable is also an effective method.

elsewhere in these specifications and as indicated on the wiring plans, a system of metallic baseboard wireways for (indicate whether single raceway for 115-volt service, single raceway for telephone and signaling service, or two parallel raceways forming two complete systems, one system to be used for 115-volt service and the other for telephone and signaling service.)

This system shall be installed complete with junction boxes, outlet fittings, cross-connected raceways, circuit conductors and wiring devices as indicated on plans. The system shall be as manufactured by \_\_\_\_\_

\_\_\_\_\_ Company or approved equal.

Surface raceway would be specified as follows:

#### 6.49 (B) Surface raceways.

Furnish and install where indicated made by the \_\_\_\_\_ Company, or approved equal. Raceway, elbows, fittings and outlets shall be of the same manufacture and designed for use together. They shall be of a size approved for the number and size of wires indicated and shall be installed in an approved and workmanlike manner. Runs shall be parallel or at right angles to walls and partitions. Connections shall be made to other types of raceways in an ap-

proved manner with fittings manufactured for the purpose and application.

Where combination metal raceways are installed for signal, lighting and power circuits, each system shall be run in separate compartments identified by sharply contrasting colors on interior finish. Compartments shall maintain same relative position throughout the system.

The number of conductors installed in any raceway shall not be greater than the number for which the raceway is approved. In no case shall more than 10 conductors be installed in a single raceway compartment.

Metal framing would be specified as follows:

The use of a steel channel, all-bolted framing member as a combination rigid electrical fixture support and lighting branch circuit conductor raceway has been approved by the Underwriters Laboratories. Such approval is contingent upon the continuous channel opening between fixture connections being equipped with snap-on closure strip.

This cold-rolled steel channel with a continuous slot comes in a square and rectangular cross section; has a serrated nut and bolt assembly which can be inserted and tightened anywhere along the length of the slot; was originally marketed as a fram-

ing member. The strength and adaptability of the channel quickly resulted in its use for supporting fluorescent lighting fixtures in continuous row, end-to-end, and alternate spacing patterns. The logical use of the empty space inside the channel as a raceway for the fixture branch circuit conductors followed.

Before specifying this type of channel as a combination fixture support and conductor raceway, secure written approval of its use as such from the inspection authorities having jurisdiction in the area in which the installation is to be made.

## 6.5 Underflow Systems

### 6.51 Underfloor duct systems.

Furnish and install a complete (metal) (fiber) underfloor duct system as shown on the plans. System shall consist of (number) ducts, as indicated, to provide raceways for (110-volt) (telephone) (low tension) system wiring. All duct, fittings, junction boxes, outlets, connectors, and supporting brackets shall be as manufactured by the \_\_\_\_\_ Company, or approved equal and designed for use with this system.

Connection between the duct system and distribution cabinets and wall outlets shall be made with rigid or flexible steel conduits, or fittings specially approved for this purpose.

Duct, junction boxes, outlets, and connections shall be installed according to manufacturer's recommendations and with the best workmanship. All surface covers, where intended to be flush with the finished floor, shall be level and true. All inserts shall be sealed against entrance of moisture. Dead ends of all ducts shall be closed and sealed.

Unless otherwise indicated, all outlets for all systems shall be installed and wired complete.

Suitable markers shall be installed at the end of every line of raceway to mark the line of the duct. Suitable markers shall be installed to act as base points for locating duct outlets for future use.

Regulations governing underfloor raceway installations are given in Article 354 of the NEC.

Of specific advantage in electrical modernization work is the flush type floor duct whose flat metal top is laid flush with the concrete floor. This type of duct reduces the depth

of channeling necessary to install a flexible floor distribution in existing concrete slab construction. Such duct must be covered with a substantial linoleum or equivalent floor covering at least 1/8-inch thick.

### 6.52 Cellular steel floor.

Building construction in the areas shown consists of cellular steel floor of a type approved for use as raceways for electrical conductors.

In these areas, wiring distribution for the 110-volt branch circuits, branch telephone circuits, and low tension (any other) systems, shall be installed in the floor cells, as noted on the plans.

Furnish and install all header ducts (floor or ceiling type), end closures, feed connections, floor covering adapters, outlets and taps as listed and shown on the plans. All devices shall be as approved by the Underwriters' Laboratories for use with cellular steel floor systems and as supplied by the \_\_\_\_\_ Company, or approved equal.

Cover plates, furnished by others, shall be brushed with cold flowing compound and attached to the floor by self tapping screws.

All junction units shall be adjusted to screed line and leveled before concrete pour. Floor covering adapters must be of a size to conform to the thickness of floor covering to be used.

End closures shall be sealed as recommended by the manufacturers.

All fittings and outlets shall be designed for the type of floor used and be installed in an approved manner according to instructions to be supplied by the manufacturer.

The cellular steel floor shall be grounded at a suitable location in accordance with local regulations.

The headers, outlets, extensions from cells, etc., shall be roughed-in as a system and all wire shall be pulled after fill and finish are completed.

Install suitable markers, identifying particular cells of each system, on top of selected cells and finish flush at screed line. Extend marker through floor covering with a grommited screw. There shall be one marker per system for every 200 sq ft of floor area, and not less than two per system per room, as directed.

A total of \_\_\_\_\_ floor taps and 110-volt (specify type) outlets shall be cut in where directed upon occupancy. These shall be wired complete, with a maximum of \_\_\_\_\_ outlets per

circuit. Furnish \_\_\_\_\_ outlets, complete with taps, to be used as spares.

A total of \_\_\_\_\_ floor taps and (specify type) low-tension floor outlets shall be cut in where directed upon occupancy. Furnish \_\_\_\_\_ outlets, complete with taps, to be used as spares.

For specific regulations concerning the use of cellular steel floor cells as raceways for electrical conductors, see Article 356 of the current edition of the National Electrical Code.

Electrical manufacturers produce header ducts and outlet fittings and accessories for specific types of cellular steel floor systems. It is important that the header ducts and fittings specified are designed for installation with the type cellular floor used in the building.

## 6.6 Hazardous Locations

Design of electrical installations is exceptionally critical in hazardous areas where there is the slightest possibility of an explosion or fire resulting from an electric spark. Types of equipment and methods of wiring and installation are strictly controlled and limited by specific regulations in Article 500 of the current issue of the National Electrical Code.

When designing and installing electrical systems for this type of area, carefully check the class of hazard against the equipment listing. Secure the owner's written statement as to the type of operation to be carried on within the area, and check the design and proposed layout with the local inspection authorities. After determining definitely the degree of hazard and NEC classification, follow carefully the Code regulations governing installations in that type of area.

Extreme care should be exercised in handling and installing equipment in hazardous locations. It should be stored away from dust and dirt. Fitting and enclosure covers should not be removed before installation; machined and threaded surfaces should not be marred. All threads should be carefully aligned before cover or bolt is tightened. All conduit and box connection threads should be made up tight with at least five threads engaged. Sealing fittings must be properly installed and filled with the proper sealing compound. Failure to observe these precautions may result in a dangerous defective joint.



All equipment, fittings and wiring installed in the \_\_\_\_\_ area shall be as approved by the NEC for Class \_\_\_\_\_ Division \_\_\_\_\_ locations. Materials shall be of the best quality designed and approved for the type of hazard listed. Installation shall be made by mechanics thoroughly experienced in this type of work and workmanship shall be of the best quality and skill to assure maximum safety. Sealing fittings shall be properly installed at all required locations in accordance with Code regulations.

Fittings shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

Switches and controls, as listed, shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

Lighting fixtures, as listed, shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

## 6.7 Accessory Fittings

### 6.7.1 Outlet boxes.

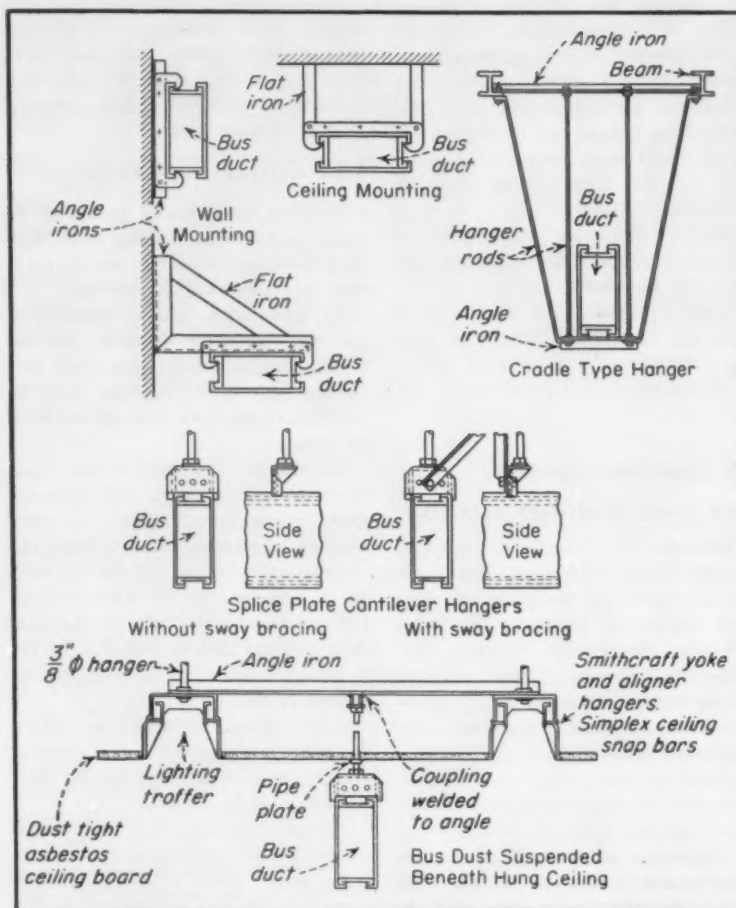
All outlet boxes shall be of galvanized steel, at least 1½ inches deep and of sufficient size to accommodate the wiring devices to be installed at the outlet location. Boxes for ceiling and interior bracket-mounted fixtures shall be equipped with fixture studs in the center of the box. All boxes shall have mounting lugs or ears for covers. Boxes shall have knockouts for conduit terminations and approved clamps where armored cable is used.

Where indicated on the plans, and noted in these specifications, outlets on exposed conduit systems shall be of the threaded-hub, cast metal, conduit type fitting suitable for the wiring devices to be installed. Where exposed metal raceway is used, outlets shall be of sufficient diameter to seat the fixture canopy.

Standard deep type outlet boxes (concrete rings with appropriate covers) shall be used in floor slab construction where concealed conduits enter sides of boxes to clear steel reinforcing rods.

Outlet boxes for wiring devices in finished walls shall be one-piece standard gang type of size to accommodate number of devices noted. Boxes shall have plaster covers to bring box openings flush with finished wall or not more than ¼-in back of same.

Bracket outlets shall be located \_\_\_\_\_ ft, \_\_\_\_\_ in. above finished



Methods of rigidly supporting plug-in power bus duct in open and suspended ceiling areas.

floor level, and centered on columns or above doors when installed in these locations.

Wall switch outlets shall be set \_\_\_\_\_ ft, \_\_\_\_\_ in. above finished floor. When located near doors they shall be at a height of \_\_\_\_\_ feet, \_\_\_\_\_ inches and installed on the lock side of the door.

Clock outlet boxes over doors shall be installed at a height which will center the clock between top of door trim and ceiling. When such outlets occur on blank walls, they shall be installed \_\_\_\_\_ ft, \_\_\_\_\_ inches above the floor, or a height to meet architectural conditions.

Outlet boxes for concealed telephone and signaling systems shall be of the 4-in. square type with plaster cover and bushed-opening (¾-in) cover plate. Telephone wall outlet boxes shall be set flush \_\_\_\_\_ in. above floor level unless otherwise noted. Signal system outlets shall be set flush in the wall \_\_\_\_\_ in. above

floor level as indicated on the plans.

Boxes for floor outlets shall be of the cast-metal, threaded conduit-entrance, waterproof type with means for adjusting cover plate to finished floor level. Boxes shall be approximately 4 in. in diameter and 3½ in. deep, with an approved gasket or seal between adjusting ring and box.

Cover plates on floor boxes shall be of heavy brass with permanent ring or flange and rubber gasket. Plates shall have \_\_\_\_\_ in. diameter threaded hole in center for installation of a flat plug or fitting for receptacle as indicated by symbol on plans.

Outlet boxes shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

Watertight floor boxes shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

### 6.7.2 Junction or pull boxes.

Junction or pull boxes not over 190 cubic inches in size shall be stand-



ard outlet boxes. Junction or pull boxes over 150 cubic inches in size shall be constructed same as cabinets with covers of same gauge metal as boxes and secured by screws or bolts. All boxes shall be coated inside and out to prevent corrosion.

Junction boxes in main service conduits shall be ample size. All other junction boxes shall be not less than 4 in. square by 1½ in. deep. Removable covers must be accessible at all times. Boxes on concealed conduits shall be set with covers flush with finished plaster line, unless otherwise noted on the plans. Junction and pull boxes of appropriate dimensions for conduits and conductors noted shall be installed where shown on drawing, and in addition where necessary or convenient for installing the wires.

### 6.73 Wiring devices.

Where shown on the plans furnish and install wiring devices indicated by the symbols. Devices shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

Flush switches shall be tumbler type, "T" rated, unless otherwise noted on the plans. Switch mechanism shall be completely enclosed in stable composition or ceramic housing. Terminal screws or connectors shall be designed to accommodate and firmly terminate up to No. 10 solid conductors.

Switches controlling 125-volt lighting or heating loads in excess of 500 watts and up to 1500 watts shall be rated at not less than 20 amps.

Switches controlling or disconnecting motor loads in excess of ½ hp shall be horsepower-rated and approved for motor control or disconnect service.

Switches shall be single-pole, double-pole, 3-way or 4-way as indicated by the symbol. Where tumbler switches operate vertically, single or double pole switch shall be "on" in the upper position. If operated horizontally single- or double-pole switches shall be "on" in the left position.

Switches indicated by the appropriate symbol shall be lock type, key operated.

Where more than one switch is shown at one outlet, they shall be installed under one plate in an order appropriate to the location of the outlets controlled.

### 6.74 Silent switches.

Switches shall be of the sealed mercury button type designed for installation in standard switch boxes. They shall be flush tumbler type mounted vertically. Single-pole units shall have "on" and "off" positions indicated on the handle.

Switches shall be of the standard mechanical type with specially designed mechanism for quiet operation. They shall be flush type mounted vertically and single-pole units shall have "on" and "off" positions indicated on the handle.

### 6.75 Receptacles.

a. Plug receptacles, unless indicated as special purpose, shall be flush type 15-amp, 120 volts, duplex grounding type. Receptacles shall be designed to accept standard 2-wire parallel blade connector caps or 3-wire grounding connector caps.

b. Plug receptacles, unless indicated as special purpose, shall be flush type 15-amp, 120-volts triplex. Receptacles shall be designed to accept standard 2-wire parallel blade connector caps.

c. Plug receptacles, unless indicated as special purpose, shall be flush type 15-amp, 120 volts, duplex type with T slots. Receptacles shall be designed to accept either 2-wire parallel blade or 2-wire tandem blade connector caps.

d. Where indicated on the plans, duplex receptacles shall be of the split-circuit type with one outlet of each receptacle being switch controlled, the other energized at all times. Receptacles shall have "T" slots to accept either 2-wire parallel or 2-wire tandem blade caps.

Receptacles shall be designed to grip both sides of the connector blades.

Terminal screws or connectors shall be designed to accommodate and firmly terminate up to No. 10 solid conductors.

Where indicated on the plans, provide a combination fan hanger and receptacle of suitable strength to support a 16-in. oscillating fan at all fan wall outlets. The receptacle shall be of standard type (single) and the hanger shall be secured to the outlet box by supports independent of the face plate or box cover. Outlet box shall be securely fastened in place. In all cases where conduit runs do not extend vertically through fan outlet provide a conduit nipple at least 12-in. long built into wall construction vertically and opposite the circuit conduit. Unless otherwise noted, fan outlets shall be 6 ft 10 in. from floor and shall be set to clear window trims or other obstructions by at least 12 in.

Where indicated by symbol, furnish and install receptacles and plates for the attachment of individual synchronous electric clocks. Receptacles shall be single, and recessed below the surface of the plate to permit the clock to rest against the plate with the plug in place.

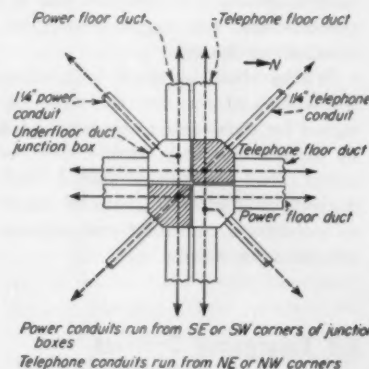
Special purpose receptacles shall be flush type of the capacity and design indicated or required for the equipment or appliance connected. They shall be designed to receive connector caps of appropriate rating and polarity only.

Plug receptacles where indicated by symbol shall be of the locking type. Locking receptacles shall be \_\_\_\_\_ pole, 15-amp, 120-volt rating unless otherwise indicated and shall be so designed that a cord, when connected by means of the matching connector cap, cannot be pulled from the receptacle until the locking feature is disengaged.

Receptacles for heavy duty industrial service, special voltages, hazardous areas and other special uses and environments are available for a variety of portable connector applications. Such receptacles are usually described in specifications by reference to the particular catalog numbers of one or more manufacturers.

### 6.76 Plates.

Furnish and install wall plates for all wiring devices, signal and telephone outlets. Plates shall be (com-



One method of feeding a 2-duct underfloor duct system at junction box to distribute power and communication circuits.

position, brass, etc.) of—thickness. (Add color, finish, special markings as required.)

When devices are installed in exposed fittings or boxes the plates or covers shall be of a type designed to fit the fitting or outlet box.

### 6.77 Low voltage devices.

Low voltage relay switching provides switching control similar in operation to the remote control of motors on industrial machines. Circuit switching is performed by relay switches. The relay coils are operated by momentary contact devices from a low voltage supply. Paragraphs marked "a" are for sequence systems, paragraphs "b" or "c" for positioning systems.

Outlets and circuits indicated by the appropriate symbol on the plans are controlled by a remote control low voltage relay system.

Furnish at each outlet where indicated a relay switch installed in a box knockout and connected in an approved manner.

Furnish and install at each location where indicated a remote control relay switch cabinet complete with the number of relays shown. The relays shall be installed in barriers which effectively isolate the circuit conductors from the low voltage control wiring.

Switches indicated by the appropriate symbol are low voltage remote control type.

Furnish and install at each switch outlet one or more, as indicated, momentary contact low voltage switches of an approved type designed specifically for low voltage remote control switching service.

a. Switches shall be 2-wire, single-pole, normally-open, to operate sequence on-off relays.

b. Switches shall be 3-wire, single-pole, 2-position, normally-open, to operate relays with separate solenoids for on and off positions.

a. At master switch location, furnish and install a multiple switch assembly for master switch service. Each switch shall operate the outlet or circuits indicated and shall be wired to parallel the local switch. Pilot lights associated with each button shall indicate when the relay is in "on" position.

b. At master switch locations shown, furnish and install a combination switch and selector. Manual rotation of the selector shall connect the

switch to operate each of the outlets or circuits controlled. The appropriate selector terminals shall be wired to parallel the local switch.

c. Switches shown as master switches shall operate a remotely controlled, electrically operated, master selector switch. When pressed in the "on" position, the switch shall cause the selector to sweep the "on" contacts of the outlets and circuits controlled. When pressed in the "off" position, the switch shall cause the selector to sweep the "off" contacts. Selector terminals shall be wired to parallel the local switch of each outlet or circuit controlled.

Furnish and install, where shown, low voltage pilot lights of a type specifically designed to operate with the low voltage, remote control switching system.

a. Current for operating each pilot light shall be obtained from an associated current-limiting transformer installed in the relay cabinet. The primary shall be connected to the controlled circuit; the secondary shall be wired to the pilot light.

Low voltage power for relay operation shall be provided from transformers specially designed for the service and for the system installed. Transformer characteristics and installation shall conform with the requirements of Article 725, National Electrical Code.

a. (Dc operation) The power supply for relay operation shall include converters or rectifiers to provide dc operating current to the relays. Rectifiers shall be of a type specially designed for the service and shall be enclosed within the relay cabinet.

Conduit, raceways, junction boxes and outlet boxes for the low voltage control circuits shall conform with the specifications for Signal and Communications Systems.

Wiring shall be done with wires and cables of the size and type designed for the system or recommended by the manufacturer. Multi-conductor cables shall contain identified conductors, and circuits shall be wired to maintain a consistent and uniform identification scheme.

## 6.8 Emergency Systems

### 6.81 Lighting.

Emergency lighting systems are legally required by municipal, state, federal or other codes, or by any

governmental agency having jurisdiction. The provisions in the current National Electrical Code are intended only to apply to the installation, operation and maintenance of circuits, systems and equipment for emergency power and lighting.

While emergency lighting requirements generally apply to theatres, movie houses, and other public gathering places, some states and cities have regulations which stipulate additional occupancies for which emergency lights must be provided, such as hotels, schools, industrial plants, etc.

In many local or state regulations, the number, location and wattages of lighting outlets are prescribed, also the types and ampere-hour or full-load capacity of auxiliary emergency systems together with minimum voltages. Specifications for equipment and wiring layouts for emergency lighting should be carefully checked with inspection authorities having local jurisdiction.

In case of failure of normal power supply, the emergency lighting circuits must be automatically transferred, without an appreciable delay, to an emergency source of power. This standby power source must be able to energize, for a specified period, exit signs and specific lighting outlets to permit safe egress from a building; also, where indicated, special circuits to keep essential equipment and processes operating for the duration of the outage of the normal power system.

Current supply for emergency lighting systems may be provided by one of the following methods:

A. Two or more independent sources of supply.

B. Auxiliary standby sources of power, in conjunction with normal service.

1. Automatically charged batteries.

2. Automatically started generator units.

3. Small non-compulsory emergency battery systems.

a. Battery with charging control panel and separate battery circuits to emergency outlets (115-volt, or low voltage).

b. Unit equipment of one or more lamps, a storage battery with charging equipment and relay to energize the lamps upon failure of normal current supply. This unit is connected to conventional branch circuit on regular lighting system.

C. Connection on supply side of

main service, if sufficiently separated electrically and physically from main service to minimize possibility of simultaneous interruption of supply.

### 6.82 Independent sources.

Where two or more separate and complete systems with independent current supply can be installed, each of the systems may supply a part of the emergency lighting provided all emergency outlets supplied on each independent current supply system are energized. The several supply systems may also serve all or a part of the general lighting system.

Unless all the emergency lights served by two or more independent supply systems are kept lighted, a throw-over switch must be provided which will automatically transfer to emergency service in case of current failure.

### 6.83 Auxiliary current supply.

Auxiliary generators (System B-2) with prime movers may be used in lieu of storage batteries (System B-1), provided they are equipped with automatic controllers, and are capable of generating the full emergency load within a certain reasonable time limit after a current failure occurs.

a. Prime movers for driving auxiliary generators must be automatically started and may be:

1. internal combustion engines,
2. steam driven engines,
3. steam or water driven turbines.

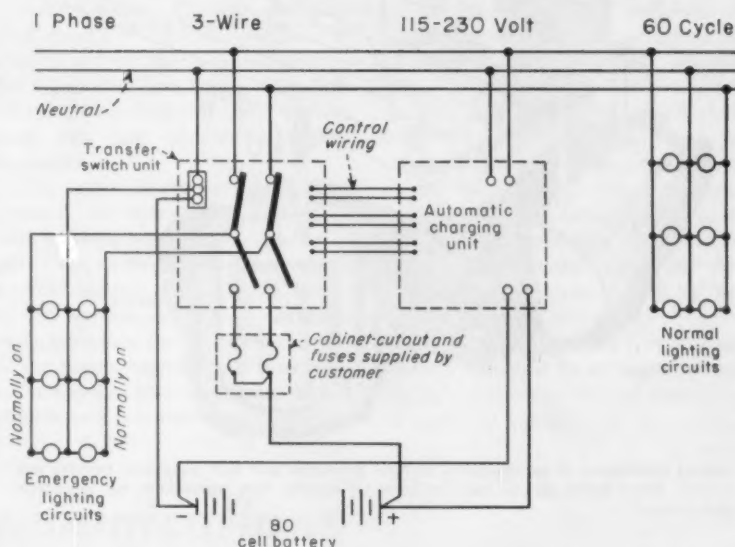
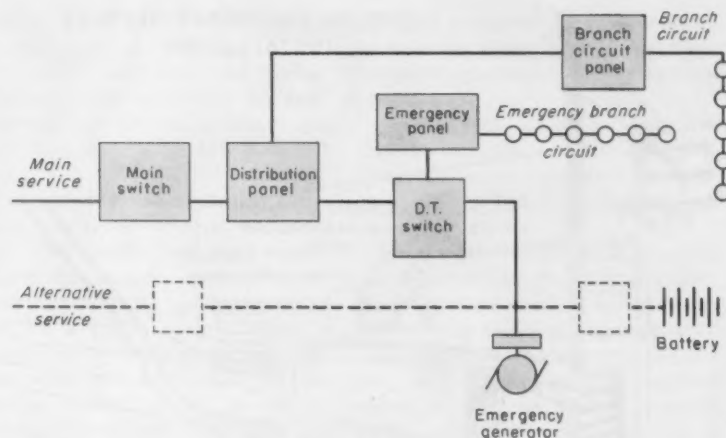
b. Automatic controllers must include approved storage batteries of the correct capacity for necessary cranking of the foregoing types of engines, or for operating the engine supply valves, as the case may be. When cranking batteries are employed, approved automatic charging devices must be provided for them. These generators commonly operate at 110 to 115 volts.

c. Automatic throw-over switches, as called for in System A, must also be provided for Systems B-1 and B-2 to connect the emergency lighting circuits to the auxiliary equipment.

d. Auxiliary generators are sometimes permitted to be installed with sufficient capacity to supply all or part of the general lighting system, as well as the emergency lighting outlets prescribed by regulations.

### 6.84 Warning signals.

Approved warning or derangement signal devices of the audible or visual



Emergency power can be provided by a standby generator, batteries, or separate electrical service from source other than normal service (top). Wiring diagram for a typical battery system is shown at bottom.

types must be provided for systems B-1 and B-2. These signals shall automatically give warning of a derangement of the emergency current sources, and shall indicate when batteries or a generator set are carrying the emergency illumination load.

### 6.85 Small systems.

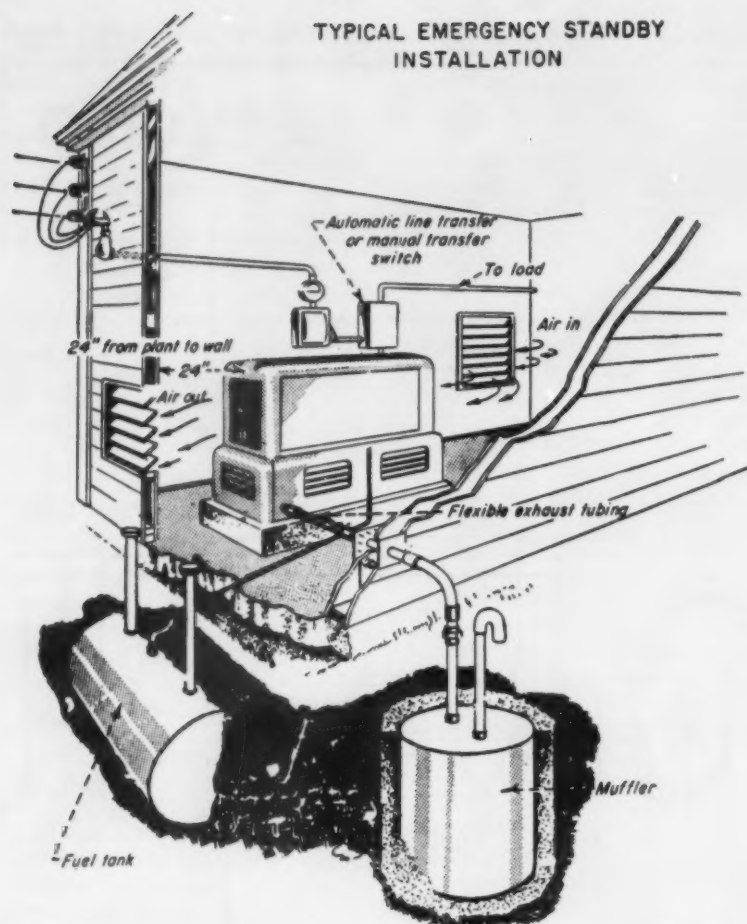
Small emergency lighting systems (B-3a) are used voluntarily in banks, stores, factories and other places that are not required to provide emergency lighting systems. These systems are designed to supply, through a storage battery, a small number of specially equipped lighting units located in several important areas. A separate circuit is run from an automatic battery control panel to these lighting

units. This circuit has no electrical connection with other normally supplied circuits. The automatic control panel usually consists of an automatic battery charging device and an automatic switch or relay for turning on the auxiliary lighting circuit whenever there is a failure in normal energy supply. A power supply connection must be provided between the control panel and the normal supply system for the throwover relay and for the automatic battery charger.

Another small emergency lighting system rapidly gaining acceptance is the unit equipment system (B-3b) in which a complete package unit contains lamps, storage battery, charger and automatic transfer relay. These units are mounted on shelves, or



## TYPICAL EMERGENCY STANDBY INSTALLATION



Typical installation of an emergency standby generator unit with automatic transfer and control. Prime mover can be gasoline or diesel engine. Note precautions for ventilation and exhaust.

brackets, at strategic locations throughout a building and connected to a nearby 115-volt branch circuit on the normal supply. The NEC requires that such units be wired permanently to branch circuit conductors, and does not permit flexible cord connections.

Furnish and install a complete emergency lighting system, as shown on the plans, including all feeders, branch circuits, emergency lighting panels. All wiring shall be in accordance with provisions of the National Electrical Code and all local regulations covering this type of installation.

### 6.86 Standby generator.

The emergency standby generator set shall be rated at \_\_\_\_\_ kw, \_\_\_\_\_ volts, \_\_\_\_\_ phase, 60 cycle. It shall consist of a \_\_\_\_\_ engine directly connected to a single-bearing, four-pole generator, and equipment to automatically start the set upon power

failure of normal source and transfer the load to the generator.

The generator shall be of saturated field, four-pole, revolving armature design directly connected to the engine flywheel by means of a semi-flexible steel driving flange to insure permanent alignment. It shall be rated at \_\_\_\_\_ volts, \_\_\_\_\_ phase, \_\_\_\_\_ cycle, \_\_\_\_\_ kw, continuous output with inherent voltage regulation within 10% from no load to full load. The engine shall be cranked through the exciter of the generator through special 12-volt cranking winding with current obtained from two 6-volt batteries. Batteries shall be recharged from the exciter with charge rate controlled by an automatic 2-step regulator.

The engine shall be of the \_\_\_\_\_ cycle, \_\_\_\_\_ cooled type with \_\_\_\_\_ cylinders and a displacement of \_\_\_\_\_ cubic inches. It shall have a rating of \_\_\_\_\_ horsepower maximum at the operating speed of \_\_\_\_\_

rpm. The engine shall be provided with automatic choke, 12-volt battery ignition and gear-driven distributor.

The line transfer control panel shall be wall mounted and contain a magnetically held transfer switch, relays to automatically start the engine upon power failure, and shall provide a cranking limiter to open the starting circuit after about 45 seconds if the engine has failed to start. A four-position control switch shall permit selection of "stop", "hand cranked", "test", and "automatic" positions. The control panel shall contain a 12-volt battery trickle charger to maintain starting batteries fully charged.

The generator unit shall contain an instrument panel with a water temperature and oil pressure gauge, battery charge rate ammeter, 12-volt panel light, stop and start buttons, manual reset circuit breaker, necessary voltmeters and ammeters and a duplex twist-tight type receptacle outlet.

The complete emergency standby generator unit shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

### 6.87 Installation.

All conductors for systems A, B-1 and B-2 must be installed in metal raceways or armored cable. No conductors of other feeders or branch circuit wiring shall be installed in the same raceways, outlet boxes, wireways or cabinets supplying the emergency lighting systems.

The switch for turning emergency lighting circuits "on" or "off" at the opening or closing of a theatre or other occupancy must, except as noted later, be limited to one switch accessible only to authorized persons. This switch should preferably be located in the lobby or other place convenient to the main entrance of the building. This requirement will usually necessitate the installation of an emergency lighting panelboard that contains a remote-controlled master switch. A remote-control switch designed to operate this master switch can thus be placed in the lobby to meet the foregoing requirement. When the emergency lighting system only requires one to three branch circuits, a single or multi-pole switch can be provided in the lobby for directly controlling the several circuits. A feeder control switch for manually switching a group of emergency cir-



cuits from the lobby is not recommended, and in most cases requires a considerable increase in the length of the feeder conductors and race-way.

It is permissible to provide a separate switch for controlling one or more circuits supplying exterior lights.

System B-3a may involve runs of considerable length to scattered outlets. When low voltage auxiliary batteries are used, the conductors should be of adequate size to avoid excessive voltage losses and to prevent a corresponding reduction of illumination intensity.

The service equipment for emergency lighting systems must be so connected that it will not be interrupted by the disconnecting of normal service equipment devices or by the functioning of normal service equipment overcurrent devices, except for the momentary delay while automatic throw-over devices are functioning. Only the emergency service over-current devices shall be placed ahead of the emergency branch circuit over-current protective devices.

#### **6.88 Storage battery system.**

Auxiliary storage battery systems of approved type and capacity may be provided instead of, or in addition to, independent sources for emergency

lighting. These batteries must also be provided with an automatic throw-over switch, and they must further be automatically maintained at a fixed minimum state of charge. These systems normally operate at 105 to 120 volts.

Furnish and install a complete emergency unit as indicated on the drawings. This standby unit shall consist of a storage battery, of sufficient capacity to carry the total emergency load for a period of two hours; a storage battery control panel to operate with current available at the building, and a suitable means for charging and maintaining the battery in a fully charged condition.

Storage battery: The storage battery shall consist of 60 cells, and shall be able to deliver the required amperes for a period of two hours, when fully charged, to a final voltage of not less than 105 volts across the battery terminals.

The automatic control cabinet shall contain a double-pole automatic switch which will transfer the emergency circuit from the normal supply to the battery circuit upon failure of the normal supply and automatically reconnect the emergency circuit to the normal supply when the service is restored. This automatic switch shall have a safe carrying capacity for

the total connected load. It shall be so mounted that it will be accessible for parts replacement or necessary adjustments.

On the face of the cabinet there shall be mounted a voltmeter, a milliammeter to read the battery charge rate and a switch for control of the emergency circuit.

Circuit protection shall be provided for protection of the normal supply circuit, and the charging device of the same type as specified for panelboards.

A rectifier, capable of charging the 60 cell storage battery described above, in one series, shall be mounted in the cabinet in such a way that it will be accessible. It shall be designed for the current available and shall be capable of charging the battery at an approximate average rate of 4.6 amps. This charger, when connected through proper resistance which shall be provided in the cabinet, shall be capable of trickle charging the battery at the proper rate. All equipment shall be left in operating condition.

Copies of instructions describing in detail the maintenance, care and operation of the equipment shall be furnished.

The storage battery emergency standby unit shall be as manufactured by the \_\_\_\_\_ Company, or approved equal.

## **7.0 Signal, Communications and Auxiliary Systems**

Clauses herein presented in bold-face type show scope and wording of typical specifications.

### **7.1 Television Antenna System**

A. Television, amplified.

#### **7.11 General.**

Furnish and install a (trade name and/or number) television antenna system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left completely equipped and in first class operating condition.

A. Television antenna system, amplified: Install custom built television antennas for channels (mention chan-

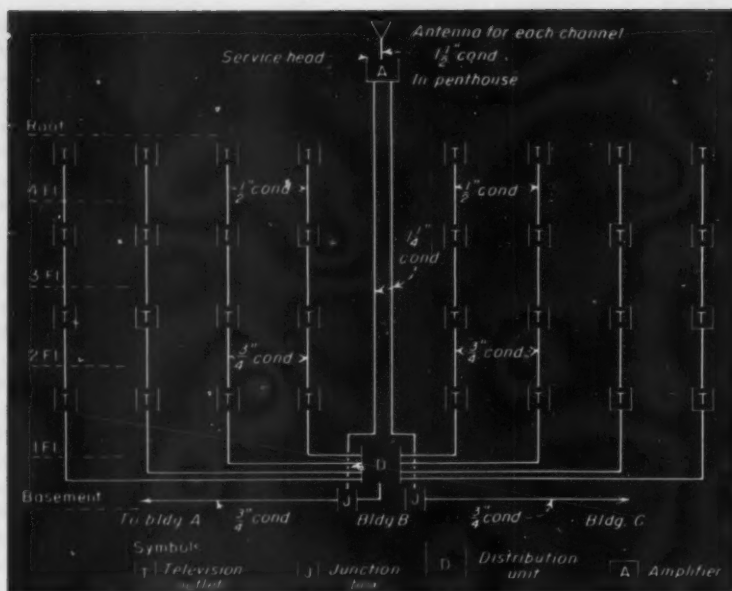
nel numbers) as desired. There shall be installed six antenna on each mast with coaxial cable to each apartment, each antenna shall be designed to match the coaxial cable transmission line. The quality of the television signal for each channel received shall be equal or superior to that which could be obtained by the use of an individual antenna for each outlet. Wiring from each antenna to the amplifier units shall be in a coaxial cable as recommended by the manufacturer. The system shall be complete with television set outlets and ground wire. The antennas shall be properly supported and braced. They shall clear the roof by at least 15 feet and be arranged so that there will be no interference between antennas. Outlets shall be installed at locations shown

on plans. Grounding of the support shall be to the nearest cold water pipe.

#### **7.12 Equipment.**

Aa. Install in each suite where shown a television set outlet on single gang metal (or plastic) plate for connecting the set to the antenna.

The outlet device for television shall be designed to completely isolate all apartments from each other, so that a short circuit, open circuit or a defective television receiver connected to any receiver outlet, shall not affect the operation of any other television receiver connected to the system. The receiver outlet shall have a compensating attenuation network, so that the signal level in the last apartment on the coaxial transmission line will be approximately the same as that of



Riser layout, television antenna system.

the first apartment on the transmission line. The signal level at the outlets shall not be less than 1,000 micro-volts on the various television channels.

Ab. Install a multi-channel amplifier where shown in ventilated steel cabinet. This shall consist of a heavy duty power supply unit, a separate amplifier for each television channel and a separate amplifier for the FM channel. Provision shall be incorporated in the amplifier so that additional television channels may be installed if necessary in the future. The amplifier shall be designed for continuous duty and shall consume not more than 300 watts of power when operated on a 125-volt 60-cycle line. A filter shall be incorporated to eliminate all FM and diathermy interference from the television channels.

Ac. Distribution equipment and line splitters for supplying branch feeders from the main trunk line may be either electronic or passive. Each feeder line shall be completely isolated from any other feeder line. They shall be completely wired in suitable steel cabinet and equipped with coaxial receptacles and plugs for connection of incoming and outgoing cables. All wiring from amplifiers to distribution and from distribution equipment to outlets shall be coaxial transmission cable.

Ad. Install where shown on roof necessary number of antennas to provide service on all television channels specified. These shall be of the directional type and connected to coaxial

cable. Where received signals at the antenna are weak, high gain, low noise figure pre-amplifiers shall be used to increase the signal levels to the rated input of the master amplifier.

#### 7.13 Operating current.

All power outlets for sets shall be connected to the lighting system in the suites and shall not be combined in same outlet box with the television set outlet. Amplifiers shall be connected to separate circuit from nearest lighting panel supplying current to the building proper.

#### 7.14 Wiring.

All wiring shall be run in approved conduit in the same manner as for the lighting system. The lead-in or down-lead wires for television shall be coaxial cable of the size and type as recommended by the manufacturer of the antenna system. Wires for ground connection shall be as recommended by the manufacturer of the antenna system. Coaxial cable shall be run in continuous lengths from the antenna to the amplifier and distribution units. This cable shall be connected to the individual television outlets by means of solderless coaxial connectors.

### 7.2 Intercommunicating Telephone Systems

A. Two station.

B. Master selective ringing and common talking.

C. Master selective ringing and

common talking, program and signal control.

D. Selective ring and common talking.

E. Selective ring and selective talking.

F. Private exchange, manual switch-board.

G. Private exchange, automatic switching.

H. Apartment selective ringing and common talking, vestibule to suites, suites to door-opener. (1) loudspeaking, (2) non-loudspeaking.

#### 7.21 General.

Furnish and install an (trade name and/or number) intercommunicating telephone system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left in first class operating condition.

#### 7.22 Operation.

A. Two station system: At the two locations shown there shall be a telephone arranged so that one station may call and converse with the other. A pushbutton shall be provided with each unit. Pressing the button at one station shall ring the bell at the other station. Lifting the handpiece (or receiver) completes the talking circuit.

B. Master selective ringing and common talking: In the main office where shown there shall be a master telephone with pushbuttons (or selector switch) to selectively call any outlying telephone. At other locations the telephone shall have a pushbutton (or selector switch) to call the master station. The master station after being called by an outlying station may call another outlying station to complete a connection between the two remote points. Only one conversation at a time is required.

C. Master selective ringing and common talking, program and signal control: In the main office where shown, there shall be a master telephone with pushbuttons to selectively call any outlying telephone by sounding the same buzzer in classroom clocks and bells at other locations as are used in the program system. At all other locations except in principal's office the telephone shall be furnished without a pushbutton or audible signal. Lifting the receiver on any outlying telephone shall sound a buzzer at the master telephone. The master

station after being called by an outlying station may call another outlying station by pushing its corresponding pushbutton to complete a connection between the two remote points. A supervisory lamp shall be provided to signal when the two outlying stations have completed their conversation, and an associated throw-over switch is used for connecting from the lamp to the buzzer and vice versa. Only one conversation at a time is required. It shall be possible at the master station to transfer the audible signals from one program circuit to another without disturbing the overall program setting or any of the wiring.

D. Selective ringing and common talking system: At each location shown there shall be a telephone arranged for calling and conversing with any other telephone in the system. Each station shall be provided with pushbuttons (or selector switch) for selectively ringing any other station. Only one conversation at a time is required.

E. Selective ringing and selective talking system: At each location shown there shall be a telephone arranged for calling and conversing with any other telephone in the system. Each station shall be provided with pushbuttons (or selector switch) for selectively ringing and selectively talking with any other station in the system. It shall be possible to use all telephones simultaneously provided that the called station is not pre-occupied.

F. Private exchange, manual switchboard system: In the switchboard operator's room there shall be a common return, lamp signal type manual switchboard arranged to call and interconnect any telephone in the system. At other locations where shown there shall be a telephone of the type designated by the symbol. The telephone operator may call and converse with any outlying station, and any outlying station may call and converse with the operator, or be connected through the switchboard so that two outlying telephones may converse. Removing the handset (or receiver) on any outlying station will cause its associated lamp to light at the switchboard. Connection from one line to another may be made by inserting the plugs of the cross-connecting cords into the calling and called station line jacks. Operator listens and converses through a headset and breast-plate transmitter or handset, connecting into individual cross-connecting sets by means of listening

and ringing keys. Each set of cross-connecting cords shall be provided with supervisory lamps to indicate completion of a conversation between two stations. A buzzer and silencing switch shall be provided as a night signal.

G. Private exchange, automatic switching system: In the machine room in basement there shall be a complete automatic exchange unit. This shall consist of an automatic relay (or step-by-step) switching unit, cable distribution rack, rectifiers, control panel and battery with rack. At other locations where shown there shall be an automatic dial type telephone of the type designated by symbol. The system shall enable any station in the system to call and converse with any other station without the assistance of an operator. Lifting a handset (or a receiver) on the calling station and dialing the desired number shall automatically ring the called station. The talking circuit is completed when the handset (or receiver) is lifted at the called station. A busy signal shall be audible in the handset (or receiver) of the calling station when the called station lines are preoccupied.

H. Apartment selective ringing and common talking system, vestibule to suites, suites to door-opener: In each tenant's suite there shall be a telephone. A pushbutton shall be provided thereon to operate the door-opener at the main entrance. In the vestibule there shall be a telephone and plate with pushbuttons and cardholders for every suite in the building. Pressing a pushbutton thereon will cause a bell to ring in the corresponding suite telephone. Only one conversation is required at one time. Provide a buzzer in each suite telephone to operate from a pushbutton at the entrance to the suite.

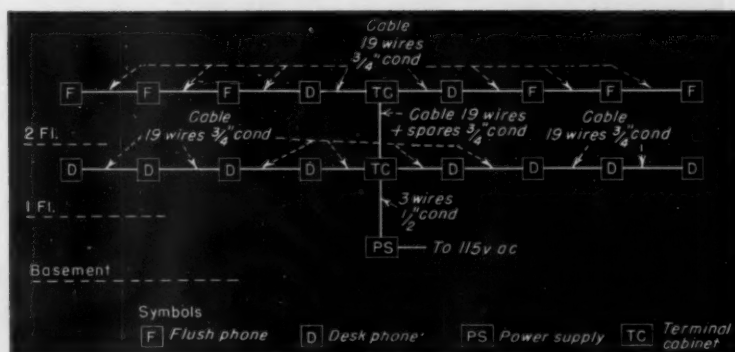
## 7.23 Equipment.

Aa. Install at each location in office a handset on cradle type desk (or flush or surface wall mounting with handset or with watchcase receiver and built-in transmitter) telephone having mounted thereon a pushbutton for calling the other telephone on the system. (Provide desk unit with 6-ft flexible cable, terminal strip box and buzzer signal.)

Ba. Install in office where shown a master handset on cradle desk (or flush or surface wall mounting with handset or with watchcase receiver and built-in transmitter) telephone having mounted thereon—pushbuttons (or selector switch with—points) to call all outlying stations. At all other locations install the type of telephone indicated by symbol having mounted thereon one pushbutton (or selector switch with one point) to call master station. (Provide desk unit with 6-ft flexible cable, terminal strip box and buzzer signal.)

Bb. Install in or near power supply a retardation coil and connect to telephone system.

Ca. Install in office where shown a master telephone with handset mounted on a signal control board, flush or surface wall mounting, having the required number of pushbuttons and associated cardholders for every outlying telephone and other audible signals used in the program system. Adjacent to each pushbutton there shall be a set of openings each one representing a program circuit. A complete set of plugs shall be furnished, made to fit in these openings, and permitting internal connections from one program circuit to another, by means of horizontal circuit bars and vertical program circuit bars. A buzzer and a pilot lamp signal



Riser layout, common talk—selective ring telephone system.



shall be provided on this unit with control switch so that the lamp may be used as a supervisory disconnect signal, and the buzzer may be used as a central calling signal. At all outlying points install the type of telephone indicated (flush wall, flush plug-in or surface wall) by symbol without signal. Where cradle desk telephones are shown provide same with 6-ft flexible cable, terminal strip box and associated buzzer signal.

Da. Install at each location where shown a handpone on cradle type desk (or flush or surface wall mounting with handpone or with watchcase receiver and built-in transmitter) telephone having mounted thereon—pushbuttons (or selector switch with —points) to call any other telephone in the system. (Provide desk unit with 6-ft flexible cable, terminal strip box and buzzer signal; others with bell signal)

Db. (Same as paragraph Bb.)

Ea. Install at each location where shown a handpone on cradle type desk (or flush or surface wall mounting with handpone) telephone having mounted thereon—locking push-buttons (or reset selector switch with —points) to call any other telephone in the system. (Provide desk unit with 6-ft flexible cable, terminal strip box and buzzer signal; other bell signal.)

Fa. Install at each location where shown a handpone on cradle type desk (or flush or surface mounting with handpone or with watchcase receiver and built-in transmitter) telephone. (Provide desk unit with 6-ft flexible cable, terminal strip box and buzzer signal; other with bell signal.)

Fb. Install in telephone switchboard room a free-standing (or turret or desk type) common return, lamp signal, manual telephone switchboard. This unit shall be equipped for—line and lamp jacks (for all stations plus 10%) or nearest largest standard switchboard manufactured, —cross-connecting cords and ringing and listening keys, (based on five for first 50 lines plus one for each 10 additional lines) buzzer and switch, headset and breastplate transmitter with cord and plug, line terminals in rear. The cross-connecting cords shall be complete with supervisory pilot lamps.

Ga. Install at each location where shown a handpone on cradle desk (or flush or surface wall mounting with handpone) telephone with automatic dial and ringer. (Provide desk unit with 6-ft flexible cable and terminal block)

Gb. Install in machine room a complete automatic exchange unit. The machine switching equipment shall be fully equipped for—lines plus 25% space for future expansion, including switching and rack facilities, ringing apparatus, rectifier equipment, battery and rack.

Ha. Install in each suite a flush (or surface) wall type telephone provided with one pushbutton and cardholder. (1) A talk and answer speaker mounted behind grille front with press-to-talk button; (2) a watchcase receiver built-in transmitter and hook-switch; (1, 2) together with necessary terminals and backbox.

Hb. Install in vestibule a (1, 2) loudspeaking telephone; (2) non-loud-

speaking telephone with armored cord receiver and built-in transmitter; (1, 2) with — pushbuttons and cardholders (one for each suite) and flush louvered lamp for illuminating plate. Outer frame shall be designed to contain government approved mailboxes. Backbox to be provided for the telephone in vestibule.

Hc. Install a mortise type door-opener in main entrance door frame and fasten securely in place, and even with door lock.

## 7.24 Terminal strip cabinets.

Furnish and install where shown on plans, flush steel cabinets with hinged doors equipped with lock and keys. The terminal strips shall have sufficient pairs of terminals for all conductors, plus 10% spares. Terminal strips must be mounted on a sheet of insulating material.

## 7.25 Operating current.

The system shall operate from a dry plate rectifier power supply cabinet with a capacity of sufficient size to carry the load of the system. This unit shall have an input of 115 volts 60 cycle ac derived from a separate circuit from the nearest lighting panel.

## 7.26 Wiring.

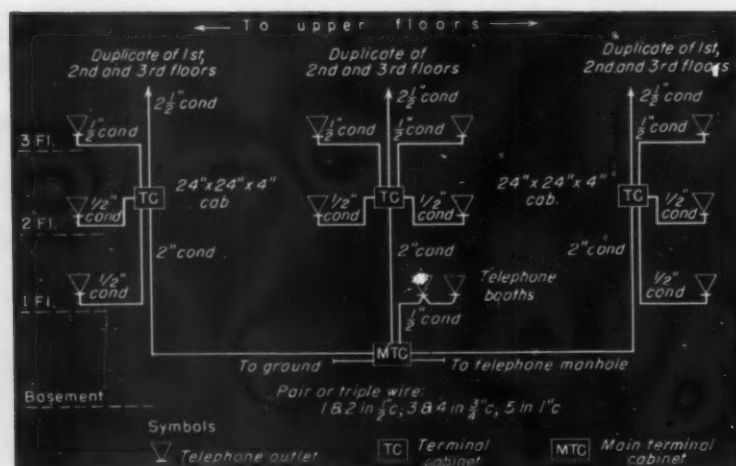
All wiring shall be run in approved conduit in the same manner as for the lighting system. The wire shall be color-coded and in general shall be standard heavy braided type, except in damp locations (or underground where it shall be lead-covered.) (A) Twisted pair No. 19 B & S gauge and two No. 18 single B & S gauge. (B, D, G, H) Cable with 2 pair No. 18 B & S gauge, balance single or paired No. 22 B & S gauge. (F, G) Cable with pairs No. 22 B & S gauge, branches twisted duplex or triplex No. 19 B & S gauge. (D) One twisted pair No. 19 B & S gauge, one common No. 18 B & S gauge, plus one No. 18 B & S gauge for each signal.

## 7.27 Finish.

Finish on instruments shall be standard insofar as possible except annunciators and manual switchboards which shall be as approved by the architect.

## 7.28 General.

Furnish and install a conduit system for the public telephones as recommended and specified by the (name of local public telephone company) and



Riser layout for public telephone system.



described in these specifications and indicated on wiring plans.

Furnish and install outlet boxes as required by the telephone company. Where these outlets are combined with other outlets proper barriers must be provided.

### 7.29 Terminal strip cabinets.

These cabinets shall be supplied and installed as required by the telephone company less terminal strips, however, they must be of proper size and have the proper gutter requirements.

## 7.3 Sound Systems

- A. Single channel.
- B. Multi channel.
- C. Intercommunication, 2-station.
- D. Intercommunication, master selective ringing, common talking.
- E. Intercommunication, selective ringing, common talking.
- F. Intercommunication, selective ringing, selective talking.

### 7.31 General.

Furnish and install a (trade name and/or number) sound channel (or sound communication) system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left in first class operating condition.

### 7.32 Operation.

A. Single channel sound system: Install a single channel sound distribution system providing facilities for the distribution of a radio, phonograph or microphone program to any individual, selected group or all loudspeakers in the system. Install in a turret on desk or on console where shown in special room, complete receiving and distribution equipment and a microphone. It shall be possible to supervise rooms by means of a monitoring loudspeaker and to carry on a two-way conversation with an outlying station by operating a "talk-listen" switch and talking into the microphone. Each circuit control key shall be equipped with pilot lamp. Each loudspeaker in rooms shall be provided with privacy switch or the system shall be equipped with an oscillator to produce a sound in the loudspeaker being supervised. Install additional microphone outlets in prin-

cipal's office and on stage in auditorium. Install in each classroom a loudspeaker of the permanent magnet dynamic type. Install in the auditorium two high fidelity dynamic loudspeakers with directional horns mounted behind grille, one on each side of the stage, and provide with volume control.

B. Multi channel sound system: (Similar to paragraph A except for additional radio and distribution equipment for two or more channels). Provide three channels, two for radio and one for intercommunication. Furnish hold relay on buzzer circuit with pushbutton switch to silence buzzer. Provide special pushbutton for air raid signal.

C. Intercommunication, two-way sound system: At the two locations shown on plans there shall be a sound intercommunicator arranged so that one station may call and converse with the other. A "press-to-talk" switch shall connect the speaker-microphone so that the calling station may converse with the called station. A separate key or switch shall be used for signaling the called station. Provide conference key if desired.

D. Intercommunication, master selective ringing, common talking system: In the manager's office there shall be a sound intercommunicator of the master type arranged so that any outlying station may be called individually or for conference by operating an individual or all calling buttons. By operating the "press-to-talk" switch the speaker-microphone is connected to any or all outlying stations. The outlying stations have a calling button to

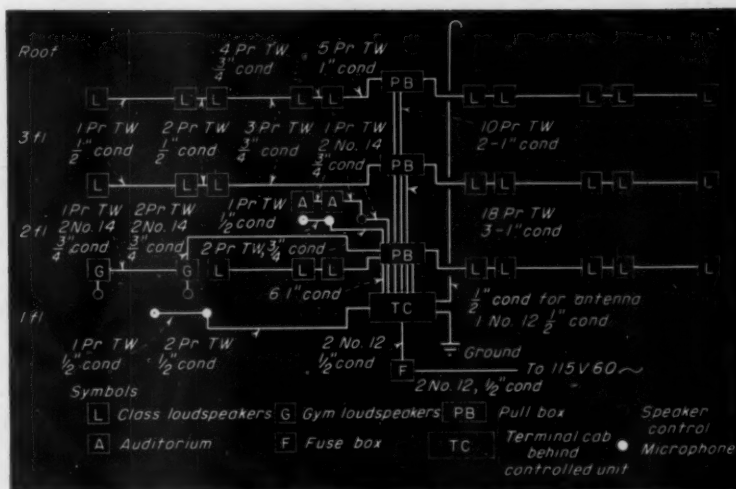
call the master station and a "press-to-talk" switch for conversing.

E. Intercommunication, selective ringing, common talking system: In each office where shown on plans there shall be sound intercommunicator of the multiple type arranged so that any station may call and converse with any other station in the system. A "press-to-talk" switch shall connect the speaker-microphone so that the calling station may converse with the called station. A separate key or switch shall be used for calling each of the other stations individually. (A conference key may be provided at one station to talk to a group or all of the other stations.) Only one conversation at one time is required normally.

F. Intercommunication, selective ringing, selective talking system: In each office where shown on plans there shall be a sound intercommunicator of the selective type arranged so that any station may call and converse with any other station in the system. A "press-to-talk" switch shall connect the speaker-microphone so that the calling station may converse with the called station. A separate key or switch shall be used for calling each of the other stations individually. (A conference key may be provided at one station to talk to a group or all of the other stations.) As many conversations as there are pairs of stations are required normally.

### 7.33 Equipment.

Aa. Install in each classroom a semi-flush permanent magnet dynamic type loudspeaker with an 8-in. cone and baffle in metal or wood



Riser layout school sound system.

case. In laboratories, gymnasium and science rooms install an 8- or 12-in. loudspeaker in same type of case. In auditorium install two high fidelity coaxial loudspeakers with directional horns equipped with a 12- or 15-in. fidelity cone. Provide a volume control unit on rear wall auditorium and gymnasium for loudspeakers.

Ab. Install on stage in auditorium three input, three-way polarized microphone receptacles with single gang metal plate, and a dynamic microphone with switch mounted on an adjustable floor stand with 30 ft of cord and a plug. Install a floor box outlet toward rear of auditorium with microphone outlet for lecture purposes. Install a microphone in the principal's office to be of the desk type complete with 10-ft cord, plug and receptacle.

Ac. Install in room where shown a turret on desk or console containing the necessary voltage amplifier, power amplifier, radio receiver, phonograph reproducing unit, distribution switch and pilot lamp panel, monitor loudspeaker and all controls for regulating volume and tone. The radio receiver shall be superheterodyne having high sensitivity over the entire broadcast, shortwave and frequency modulation bands. The phonograph reproducing unit shall be of the automatic record ejector type, suitable for playing a multiple of records at either 78, 45 or 33 $\frac{1}{2}$  rpm. The monitor loudspeaker shall be of the 8-in. permanent magnet dynamic type and be provided with channel switches for two-way conservation. Furnish portable single record player with 10-ft cord and plug. Provide dynamic microphone with switch complete with desk stand, cable and plug.

Ba. (Same as paragraph Aa.)

Bb. (Same as paragraph Ab.)

Bc. (Similar to paragraph Ac. except with facilities for desired number of channels.)

Ca. Install where shown a desk model amplified sound intercommunicator consisting of wood (or metal or plastic) case and having mounted therein a speaker-microphone and amplifier. The surface of the case shall have a "press-to-talk" switch, a calling key or switch, a volume control switch and watchcase receiver and hook. Provide 6 ft of cable and plug.

Da. Install in manager's office a desk model amplified intercommunicator consisting of wood (or metal or

plastic) case and having mounted therein a speaker-microphone, amplifier and terminals. The surface of the case shall have a "press-to-talk" switch, calling keys or switches, (name, number) a volume control switch and watchcase receiver and hook. Provide 6 ft of cable and plug.

Db. Install in all other offices where shown a desk model amplified intercommunicator outlying station consisting of wood (or plastic) case and having mounted therein a speaker-microphone, amplifier and terminals. The surface of the case shall have a "press-to-talk" switch, a calling key or switch, a volume control switch and watchcase receiver and hook. Provide 6-ft cable and plug for power, and flexible cable and terminal block for circuit wiring.

Ea. Install in all offices where shown a desk model amplified intercommunicator for selective ringing and common talking consisting of wood (or metal or plastic) case and having mounted therein a speaker-microphone and amplifier. The surface of the case shall have a "press-to-talk" switch, calling keys or switches, (name, number) a volume control switch and watchcase receiver and hook. Provide 6 ft of cable and plug for power, and flexible cable and terminal block for circuit wiring.

Fa. Install in all offices where shown a desk model amplified intercommunicator for selective ringing and selective talking consisting of wood (or metal or plastic) case and having mounted therein a speaker-microphone and amplifier. The surface of the case shall have a "press-to-talk" switch, calling keys or switches, (name, number) a volume control switch and watchcase receiver and hook. Provide 6 ft of cable and plug for power, and flexible cable and terminal block for circuit wiring.

#### 7.34 Terminal strip cabinets.

Furnish and install where shown on plans, flush steel cabinets with hinged doors equipped with locks and keys. The terminal strips shall have sufficient pairs of terminals for all conductors plus 10% spares. Terminal strips must be mounted on a sheet of insulating material.

#### 7.35 Operating current.

The system shall operate on 115 volts 60 cycle ac (A,B). A separate circuit shall be run from the nearest lighting panel, (C,D,E,F). The intercommunicators shall be plugged

into the nearest convenience receptacle by means of the flexible cord and plug provided with the units.

#### 7.36 Wiring.

All wiring shall be in approved conduit in the same manner as for the lighting system. The wires from the source of current shall be rubber covered. (A,B) two No. 14 B & S gauge, (C,D,E,F) two No. 18 B & S gauge in flexible cord with plug. (A,B) Wiring from the main terminal cabinet adjacent to the control cabinet shall be in flexible cable supplied by the manufacturer of the system. Wiring from the main terminal cabinet to individual room loudspeakers shall be two No. 18 B & S gauge rubber covered and cotton braid with steel shield. Wiring to auditorium speakers shall be two No. 14 B & S gauge and two No. 18 B & S gauge. Wiring to auditorium volume control five No. 16 B & S gauge. Wiring to auditorium microphone receptacle one lead sheathed covered twisted pair No. 19 B & S gauge in separate conduit. Ground wire No. 12 B & S gauge from control cabinet to street side of water meter, two No. 14 B & S gauge from nearest lighting panel to control cabinet. Antenna lead-in wires to be carried from control cabinet to roof of building. (C) No extra wiring necessary. (D) Wiring between the master station and the outlying stations three common and one section to each outlying station No. 22 B & S gauge. (E) Wiring between all stations three common and one section to all No. 22 twisted. (F) Wiring between all stations three common and one pair section to all No. 22 twisted.

#### 7.37 Finish.

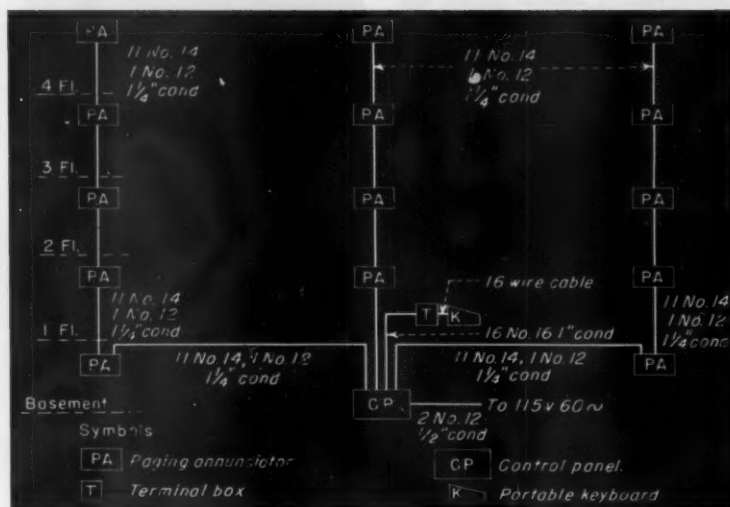
All cabinets shall be finished as directed by the architect.

#### 7.4 Paging Systems

- A. Lamp annunciator, three call.
- B. Central code transmitter.
- C. Voice, multiple circuit.

#### 7.41 General.

Furnish and install a (trade name and/or number) paging system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications, and left in first class operating condition.



Riser layout, silent paging system with buzzer.

## 7.42 Operation.

A. Lamp annunciator: In corridors at intersections and nurses' stations, doctors' lounge, library, auditorium, nurses' dining room and at other locations shown on plans there shall be a paging lamp annunciator. There shall also be enclosed therein a buzzer (or chime may be mounted adjacent to annunciator) with externally controlled cut-off switch. Adjacent to telephone switchboard operator there shall be a portable keyboard with three rows of keys for paging three persons, and provided with flexible cable with multiplug and receptacle to a flush terminal cabinet mounted in wall. Operation of the buttons in the same row will light and flash correspondingly numbered simultaneously in all lamp annunciators and pilot lights on the keyboard. When more than one person is to be paged additional rows of buttons are operated and coded lamp signals appear in sequence and flash. System shall have a capacity of 120 calls using three digit code numbers. Additional buttons shall be included to connect or disconnect the system and to operate the audible signals to obtain special attention. A control cabinet shall be installed in the machine room located in the basement for controlling the load and the sequence of calls and the flashing of the lamps. To extinguish the lamp signals the reset button on the respective row is operated.

B. Central code transmitter, single call system: In corridors, stockrooms, shops and other locations shown on the plans there shall be a heavy duty

bar chime (single stroke bell, buzzer, or single projector vibrating horn). Adjacent to telephone switchboard operator there shall be an automatic motor-driven code transmitter with "on and off" switch and facilities for setting up a pre-determined series of codes or impulses. Only one signal may be transmitted at one time but may be repeated as long as desired. (Capacity of transmitter determined by the number of persons to be paged.)

C. Voice, multiple circuit system: In corridors, stockrooms, shipping room, shops and other locations shown on the plans there shall be a loud-speaker. Adjacent to the telephone switchboard operator there shall be a desk type microphone with "press-to-talk" switch complete with flexible cable, plug and receptacle. In addition there shall be a paging selector keyboard which shall enable the operator to connect each individual, group or riser of loudspeakers. A master switch shall be included to connect all loudspeakers simultaneously regardless of the position of the other switches.

## 7.43 Equipment.

Aa. Install at each location where shown a lamp annunciator with suitable mounting for the locality. Case shall be of heavy steel construction with hinged doors. Single face flush, double and triple face vertical wall bracket mounted annunciators shall have ten lamps each. Double face ceiling or suspended horizontal mounting and double face partition mounted annunciators shall have two sets of ten lamps each. Size of indicators

shall not be less than two inches high and shall have markings applied photographically or engraved on plastic sheet. Markings shall be 1 to 9 and 0. Buzzer shall be mounted in lower part of case and cut-off switch handle shall extend through bottom of case. (Where chime is mounted adjacent to annunciator, buzzer is omitted and two terminals are provided for extension.) Backbox to be provided by the manufacturer.

Ab. Install where shown a portable selector keyboard consisting of three rows of locking buttons or switches, each button in a row representing a single digit indication on the annunciators, and arranged parallel to each other. In addition there shall be a "start" and a "stop" button, and an audible signal switch at the bottom of each vertical row. This unit shall be mounted on a 30-in. cast iron floor pedestal (or a table as selected). A flexible cable 10 ft long with multi-conductor separable plug and receptacle and flush terminal cabinet shall be provided for connection to the permanent wiring.

Ac. Install where shown a control panel enclosed in a surface steel cabinet with hinged door and lock with keys. This panel shall contain the necessary silent mercury contact relays, transformer for keyboard control, fuses, master switch and terminals.

Ba. Install where shown a heavy duty single stroke bar chime, single stroke bell (with 4-, 6- or 10-in gong) non-contact buzzer, or single projector vibrating horns as indicated by symbol. These units shall be wound to operate in multiple on the maximum voltage of the system. These shall be designed to mount on standard outlet boxes.

Bb. Install where shown a synchronous motor-driven automatic code transmitter having a selector keyboard or mechanical arm for setting the transmitter to call desired person. Index card or sheet shall be provided thereon for inserting the names of the individuals. A flexible cord and terminal box shall be provided for connection to 115-volt 60 cycle, transformer and to connect to the signal circuit.

Bc. Install where shown a silent mercury contact or gravity silver contact relay or relays enclosed in surface steel cabinet with hinged door and connect with code transmitter. Relays shall be of sufficient size to



carry the load of the entire signal devices.

Ca. Install where shown a permanent magnet, dynamic type loud-speaker single face flush, surface wall, double face wall bracket mounting or portable desk mounting as indicated by symbol. These speakers shall be equipped with volume control device and shall be of sufficient volume and size to be distinctly heard over the area in which they are installed.

Cb. Install where shown a portable type adjustable desk stand crystal microphone complete with flexible cable, plug and receptacle. A "press-to-talk" switch shall be provided on the microphone. (A floor type switch may be supplied with connecting cord to free operator's hand.)

Cc. A selector keyboard shall be provided with the microphone consisting of a portable cabinet containing a heavy duty switch for each individual, group or riser of loudspeakers and equipped with a flexible cable and terminal block in surface housing. A master switch shall also be provided below circuit switches.

Cd. Install where shown a voice paging amplifier equipped with volume control, tone control, power switch, protecting fuses, multi-tap output transformer, and receptacle for microphone, enclosed in ventilated steel cabinet. This unit shall be of ample capacity to operate the entire system.

#### 7.44 Terminal strip cabinets.

Install where shown on plans flush steel cabinets with hinged doors equipped with lock and keys. The terminal strips shall have sufficient pairs of terminals for all conductors plus 10% spares. Terminal strips shall be mounted on a sheet of insulating material.

#### 7.45 Wiring.

All wiring shall be run in approved conduit in the same manner as for the lighting system. The wires shall be color-coded and rubber covered. Feeder wires to control cabinets and relay cabinets shall be No. 12 B & S gauge. (A) Number of wires between the control cabinet or relay cabinet to annunciators 11 without audible signals, and 12 with audible signals, with common feeder wire No. 12 B & S gauge and lamp and audible signal section wires No. 14 B & S gauge. (A) Number of wires between the keyboard and the control panel

15 wires without audible signals, and 16 with audible signals No. 16 B & S gauge. (B) Number of wires between the relay cabinet and sounding devices two not smaller than No. 14 B & S gauge. (C) Number of wires from amplifier to microphone one No. 18 B & S gauge rubber covered shielded twisted pair. Number of wires from selector keyboard to loudspeakers one No. 18 B & S gauge rubber covered twisted pair for each separate section of loudspeakers. The amplifier requires one pair of No. 14 B & S gauge wires from the source of supply.

### 7.5 Fire Alarm Systems

A. Non-code, open-circuit, non-supervised.

B. Non-code, closed-circuit, supervised.

C. Master-code, closed-circuit, supervised.

D. Plain-code, closed-circuit, supervised.

E. Single-code, group, closed-circuit, supervised.

F. Coded pre-signal, closed circuit, supervised.

G. Coded shunt non-interfering, closed-circuit, supervised.

H. Coded auxilialized, Municipal connection.

I. Non-code, automatic, closed-circuit, supervised, (1) wired, (2) tube.

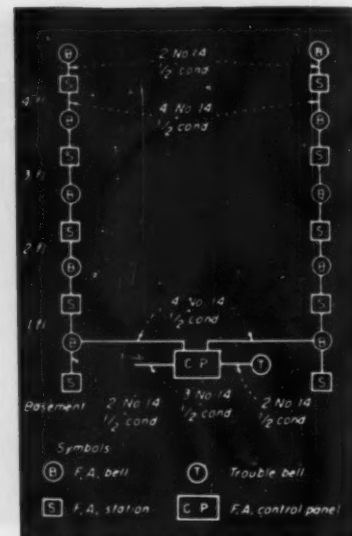
J. Coded, automatic, closed circuit, supervised, (1) wired, (2) tube.

#### 7.51 General.

Furnish and install a (trade name and/or number) fire alarm system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications, and left in first class operating condition.

#### 7.52 Operation.

A. Non-code, open-circuit, non-supervised system: At each stairway, exit and other locations shown on plans there shall be a non-code break-glass fire alarm station. At each location where shown there shall be a bell (or horn). Breaking the glass in any station shall cause all sounding devices to operate continuously until the glass has been replaced in the station which initiated the alarm. It shall also be possible to transmit a test signal from any station by open-



Riser layout, plain code fire alarm system.

ing the front cover by means of a key.

B. Non-code, closed-circuit, supervised system: At each stairway, exit, and other locations shown on plans there shall be a non-code break-glass fire alarm station. At each location where shown there shall be a bell (or horn). Breaking the glass in any station shall cause all sounding devices to operate continuously until the glass has been replaced in the station which initiated the alarm. It shall also be possible to transmit a test signal from any station by opening the front cover by means of a key. The stations and the sounding devices shall be connected to a control panel which shall permit a small supervisory current to pass through the entire system. A trouble bell shall also be provided and shall sound continuously in the event of interruption of the operating current, or an open or short circuit in the system wiring or connections.

C. Master-code, closed-circuit, supervised system: At each stairway, exit and other locations shown on plans, there shall be a non-code break-glass fire alarm station. At each location shown there shall be a bell (or horn). Breaking the glass in any station shall cause the master-code mechanism on the control panel to trip and transmit a common code on all sounding devices in the system. It shall also be possible to transmit a test signal from any station by opening the front cover by means of a key. The stations and the sounding devices shall be connected to a control panel which shall permit a small supervisory cur-



rent to pass through the entire system. The trouble bell shall sound continuously until the glass is replaced in the station which initiated the alarm. The trouble bell shall also operate continuously in the event of interruption of the operating current, or an open or short circuit in the system wiring or connections.

**D. Plain-code, closed-circuit, supervised system:** At each stairway, exit and other locations shown on plans there shall be a plain-code, closed-circuit, general alarm type fire alarm station. At each location shown there shall be a bell (or horn). Pulling and releasing the lever of any station shall cause the code number of that station to be sounded on all signal devices in the system. The stations and the sounding devices shall be connected to a control panel which shall permit a small supervisory current to pass through the entire system. It shall be possible to make a single tap test, and a silent running test on any station by operating an enclosed lever or by inserting a key into an opening provided therefore, and turning it in either of two directions. The bell shall sound in the event of interruption of current or on open or short circuit in the system wiring or connections.

**E. Single-code, group, closed-circuit; supervised system:** At each stairway, exit and other locations shown on plans of the main building there shall be a single-code, closed-circuit fire alarm station. At each location shown there shall be a local or general alarm bell (or horn). In the service and employees buildings there shall be the same type of stations and sounding devices. Pulling and releasing the lever of a station in the main building shall cause the simultaneous operation of two separate spring contacts. One shall be used to operate the local alarm sounding devices in the main building, while the other shall be used to operate the general alarm sounding devices in the service and employees buildings. Stations located in the service and employees buildings shall operate all local alarm sounding devices in the building where the alarm originates, and in addition operate all general alarm sounding devices in the other service and employees buildings and also in the main building. The stations and sounding devices in each building shall be connected to a separate group type control panel located in its respective building which shall permit a small

supervisory current to pass through the entire system. It shall be possible to make a single tap test, and a silent running test on any station by operating an enclosed lever, or by inserting a key into an opening provided therefor, and turning it in either of two directions. The trouble bell shall sound at each control panel affected and operate continuously in the event of interruption of the operating current or an open or short circuit in the system wiring or connections. A permanent record of each alarm shall be made on a punch register located near the control panel in the main building, together with the time of the day transmitted. This shall be accomplished by an automatic time stamp interconnected with the punch register.

**F. Coded pre-signal, closed-circuit, supervised system:** At each stairway, exit and other locations shown on plans there shall be a coded pre-signal, closed-circuit fire alarm station. At each location shown there shall be a general alarm bell or a pre-signal bell or chime as indicated. Pulling and releasing the lever of the station shall cause the code number of that station to be sounded on all pre-signal sounding devices only. Inserting a special general alarm plug in an opening provided therefor on the face plate containing the pull lever, and then pulling and releasing the lever, shall cause the code number of that station to sound on all signal devices, both pre-signal and general alarm throughout the system. The stations and sounding devices shall be connected to a control panel which shall permit a small supervisory current to pass through the entire system. It shall be possible to make a single tap test, and a silent running test on any station by operating an enclosed lever, or by inserting a key into an opening provided therefor, and turning it in either of two directions. The trouble bell shall sound continuously in the event of interruption of the operating current, or an open or short circuit in the system wiring.

**G. Coded shunt non-interfering, closed-circuit, supervised system:** At each stairway, exit and other locations shown on plans there shall be a coded shunt non-interfering fire alarm station. At each location shown there shall be a bell (or horn). Pulling and releasing the lever of the station shall cause the code number of that station to be sounded on all signal devices in the system. The shunt non-

interference feature shall function to insure that when a station is operating, no other station, electrically farther away from the control panel, shall interfere with its operation. The stations and sounding devices shall be connected to a control panel, which shall permit a small supervisory current to pass through the entire system. It shall be possible to make a single tap test, and a silent running test on any station by operating an enclosed lever, or by inserting a key into an opening provided therefor, and turning it in either of two directions. The trouble bell shall sound continuously in the event of interruption of the operating current or an open or short circuit in the system wiring or connections.

**H. Coded auxiliary, municipal connected system:** At each stairway, exit and other locations shown on plans there shall be a coded, auxiliary fire alarm station. At each location there shall be a bell (or horn). Breaking the glass in the door and pulling and releasing the lever of the station shall cause the code number of that station to be sounded on all signal devices in the system, and transmit the alarm simultaneously to the City Fire Department by tripping a City Master Fire Alarm Station located in the switchboard operator's office (or located on a pedestal on the street in front of the building). Interlocking contacts shall be provided on the station to prevent false alarms from being transmitted to the municipal system. For fire drills it shall be necessary to first insert a key in the special lock on the exterior of the station. The pulling of the lever under this condition shall only cause the signal devices to operate within the confines of the building. A warning signal shall be given on the control panel, immediately when the glass is broken or when the door springs open on a station. The trouble signal continues to operate as long as a station door remains open after transmitting an alarm or a drill signal. The stations and the sounding devices shall be connected to a control panel, which shall permit a small supervisory current to pass through the entire system. The system shall be double supervised using distinctively toned trouble bells, two in number, each with pilot lamps and silencing switches.

**I. Non-code, automatic, closed-circuit, supervised system:** In all rooms, corridors, closets, shops, storerooms,

attic and other locations shown on plans there shall be mounted on the ceilings (1) thermostatic detectors of the rate-of-rise and fixed temperature type, (2) thermostatic detector tubing, (1,2) properly spaced and installed to result in maximum protection in accordance with the Underwriters' requirements. At each location shown there shall be a bell (or horn). In the event of a fire the rapid rise in temperature shall be automatically detected by the thermostatic elements, which in turn shall cause all sounding devices to operate continuously throughout the system. The thermostatic elements and the sounding devices shall be connected to a control panel which shall permit a small supervisory current to pass through the entire wiring of the system. The trouble bell shall sound continuously in the event of interruption of the operating current or an open or short circuit in the system wiring or connections until the defect is remedied. The trouble signal shall include a transfer switch and a pilot light. It shall be possible to make periodic tests on the thermostatic elements whenever desired.

J. Coded, automatic, closed-circuit, supervised system: In all rooms, corridors, closets, shops, storerooms, attic and other locations shown on plans there shall be mounted on the ceilings (1) thermostatic detectors of the rate-of-rise and fixed temperature type, (2) thermostatic detector tubing, (1,2) properly spaced and installed to result in maximum protection in accordance with the Underwriters' requirements. At each location shown there shall be a bell (or horn), and an electrically tripped transmitter. In the event of a fire, the rapid rise in temperature shall be automatically detected by the thermostatic elements, which in turn shall cause a code signal to be sounded on all sounding devices, indicating the zone or section of the system in which the alarm originated. The thermostatic elements and the sounding devices shall be connected to a control panel (which may also contain the transmitters on smaller systems). A small supervisory current shall pass through the entire wiring system. The trouble bell shall sound continuously in the event of interruption of the operating current or an open or short circuit in the system wiring or connections, and, when the transmitters require winding and until the trouble is remedied. The trouble signal shall

include a transfer switch and a pilot light. It shall be possible to make periodic tests on the thermostatic elements whenever desired.

### 7.53 Equipment

Aa. Install where shown a flush (or surface) non-code break-glass hammerless fire alarm station, with hinged front door and lock with key arranged for making tests without breaking glass, and for easy replacement of the glass when broken. Flush station shall mount on standard outlet box with single gang cover. (Surface station is provided with back-casting by manufacturer).

Ab. Install where shown on plans an underdome vibrating plunger type bell (4-, 6- or 10-in. size), or heavy duty type vibrating horn of the single projector or grille type as indicated by symbol. These signal devices shall all be wound for multiple operation.

Ba. (Same as paragraph Aa.)

Bb. Install where shown an underdome vibrating plunger type bell (4-, 6- or 10-in. size), or heavy duty type vibrating horn of the single projector or grille type as indicated by symbol. These signal devices shall all be wound for series operation.

Bc. Install where shown a closed-circuit fire alarm control panel in surface (or flush) wall type steel cabinet equipped with hinged door with lock and keys. Panel shall contain all necessary relays, meter, resistances, thermal cut-out, terminals and fuses for the control and supervision of the system. Panel shall be single supervised (unless double supervised is specified) and shall operate on 115/230 volts, 3-wire supply current. Panel shall contain number of bell and station circuits required. A trouble bell shall be provided for external connection.

Ca. (Same as paragraph Aa.)

Cb. Install where shown an underdome single stroke plunger type bell (4-, 6- or 10-in. size) or heavy duty vibrating horns of the single or double projector type as indicated by symbol. These signal devices shall all be wound for series operation.

Cc. Install where shown a closed-circuit fire alarm control panel of the master type in surface (or flush) wall type steel cabinet equipped with hinged door with lock and keys. Panel shall contain all necessary relays, meter, resistances, thermal cut-out, four round master code mechanism, terminals and fuses for the

control and supervision of the system. Panel shall be single supervised (unless double supervised is specified) and shall operate on 115/230 volts, 3-wire supply current. Panel shall contain number of bell and station circuits required. A trouble bell shall be provided for external connection.

Da. Install where shown a semi-flush (or surface or weatherproof) plain code, closed-circuit, pull lever, four round code type fire alarm station with break-glass (or open) door. Stations shall be provided with a code wheel, coded as required. Facilities shall be included for making a single tap test and silent running test with key. Backbox to be provided by the manufacturer.

Db. (Same as paragraph Cb.)

Dc. (Same as paragraph Bc.)

Ea. Install where shown a semi-flush (or surface or weatherproof) single code, closed-circuit, pull lever, four round code fire alarm station with break-glass (or open) door. Stations shall be provided with one code wheel, coded as required, two sets of contacts, and two sets of terminals. Facilities shall be included for making a single tap test and silent running test with key or lever. Backbox to be provided by the manufacturer.

Eb. (Same as paragraph Cb.)

Ec. Install where shown in main building a closed-circuit master fire alarm control panel. In other buildings install a closed-circuit local fire alarm control panel. Panels shall be mounted in surface (or flush) wall type steel cabinets equipped with hinged doors with lock and keys. Panels shall contain all necessary relays, meters, resistances, thermal cut-outs, terminals and fuses for the control and supervision of the system in their respective areas. The system shall be single supervised (unless double supervised is specified) and shall operate on 115/230 volts, 3-wire supply current. Panels shall contain number of bell and station circuits required. Trouble bells shall be provided for external connections.

Fa. Install where shown a semi-flush (or surface) pre-signal, pull lever, four round type fire alarm station with break-glass (or open) door. Stations shall be provided with one code wheel, coded as required. A jack shall be provided on the pull lever plate for insertion of plug or key. Facilities shall be included for making a single tap test and silent running test with key or lever. Backbox for the instal-

lation to be provided by manufacturer.

Fb. (Same as paragraph Cb.)

Fc. (Same as paragraph Bc.)

Ga. Install where shown a semi-flush (or surface or weatherproof) plain code, shunt non-interfering, closed-circuit, pull lever, four round code type fire alarm station with break-glass (or open) door. Station shall be provided with a code wheel, coded as required, and with shunt circuit contact springs. Facilities shall be included for making a single tap test and silent running test with key or lever. Backbox to be provided by the manufacturer.

Gb. (Same as paragraph Cb.)

Gc. (Same as paragraph Bc.)

Ha. Install where shown a semi-flush (or surface or weatherproof) auxiliary, closed-circuit, pull lever, four round code type fire alarm stations with break-glass door. Stations shall be provided with a code wheel, coded as required and with municipal alarm interlocking contacts for sending an alarm. A special lock shall be provided on the door to permit fire drills without sending alarms to the municipal system. Backbox to be provided by the manufacturer.

Hb. (Same as paragraph Cb.)

Hc. Install where shown a closed-circuit double supervised fire alarm control panel in surface (or flush) wall type steel cabinet equipped with hinged door with lock and keys. Panel shall contain all necessary relays, meters, resistances, thermal cut-out, terminals and fuses for the control and supervision of the interior system, and a special switch and separate terminals for connection to the municipal system. Panel shall operate on 115-230 volts 60 cycle ac, 3-wire supply current. Panel shall contain number of bell and station circuits required. Two trouble bells shall be provided for external connections together with trouble pilot lights and silencing switches.

Ia. Install where shown thermostatic detectors of the rate-of-rise and/or fixed temperature type with open-circuit contacts and mounted on round outlet boxes and covers, for operation on 136° F. (or 190° F.) (2) thermostatic detector non-corrosive metal tubing with fitting and fastening facilities.

Ib. (Same as paragraph Bb.)

Ic. (Same as paragraph Bc.)

Ja. (Same as paragraph Ia.)

Jb. (Same as paragraph Bb.)

Jc. Install where shown a semi-flush (or surface) closed-circuit, combination pull lever and electrically tripped transmitter with break-glass door with four round code movement. Stations shall be provided with a code wheel, coded as required, and a trip coil. Backbox to be provided by the manufacturer.

Jd. (Same as paragraph Bc. when electrically tripped stations are used. Same as paragraph Cc if electrically tripped movement is on control panel.)

## 7.54 Special features.

(D,E,F,G,H,J) Install where shown on plans a punch register, take-up reel and automatic time stamp mounted on shelf with overall enclosing glass cover and supported on metal brackets. Stamping coil of time stamp to operate on 115 volts 60 cycle ac.

## 7.55 Terminal strip cabinets.

Install where shown a flush steel cabinet with hinged doors equipped with lock and keys. The terminal strips shall have sufficient pairs of terminals for all conductors plus 10% spares. Terminal strips shall be mounted on a sheet of insulating material.

## 7.56 lightning protection.

Install in each building where overhead lines enter, lightning protectors on each line, and enclose same in surface steel cabinet.

## 7.57 Operating current.

The system shall operate from (A) a transformer having a capacity of — watts (based on 10 va for each sounding device), (A,B,C,D,E,F,G,I,J) 115 volts 60 cycle ac, (A,B,C,D,E,F,G,H,I,J) connected directly to a separate circuit from the nearest lighting panel.

Install where shown a cut-out box, surface type of steel construction with hinged door with lock and keys. This cabinet shall contain the proper size fuse for each "hot wire" and provided with a solid neutral. Door shall be finished in red and stenciled with the wording "Fire Alarm".

## 7.58 wiring.

All wiring shall be run in approved conduit in the same manner as for the lighting system. The wires shall be color-coded and rubber covered or

NEC equivalent insulation. Feeder wires to control panels shall be No. 10 B & S gauge. All wires to fire alarm stations shall not be smaller than No. 14 B & S gauge. All wires to fire alarm sounding devices shall not be smaller than No. 14 B & S gauge (on large projects No. 12 B & S gauge). (A) Number of wires on 24 or 115 volts 2-wire to first sounding device and station, three thereafter. (B,C,D) Number of wires from control panel to combination of sounding devices and stations four. (E,F,G,H) Number of wires between control panel and combination of sounding devices and stations six. (I,J) Number of wires between control panel and thermostatic detectors: two.

## 7.59 Finish.

The finish of all fire alarm stations, bases of sounding devices and cabinets with control panels, terminal strips, fuses and lightning protectors shall be "fire alarm red" unless otherwise noted. Gongs of bells to be dull black grey unless otherwise noted. Bells in main lobby shall be installed behind flush bronze grille, design to be approved by the architect.

## 7.6 Watchman's Tour System

- A. Compulsory recorded tour.
- B. Supervisory proprietary tour.
- C. Central station.

## 7.61 General.

Furnish and install a (trade name and/or number) watchman's tour system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left in first class operating condition.

## 7.62 Operation.

A. Compulsory recorded tour system: At each location shown on plans there shall be a watchman's tour station. The first and last stations of each tour shall be electrical transmitters, all others between these two points are to be of the mechanical type. In superintendent's office install a paper tape printing recorder. Operation of the first electrical transmitter by inserting a special key shall cause to be printed in the recorder a designation for the "Start" of the tour. The key shall be so arranged that it



will only operate in sequence from one station to the other, and shall be "set up" when inserted in one station to fit into the following station. The key when inserted in the last electrical transmitter shall record the "Finish" of the tour.

**B. Supervisory proprietary tour system:** At each location shown on plans there shall be a watchman's tour station. All stations are provided with a jack and pilot lamp. In guard's room install a supervisory desk with recording and communication facilities. A handphong with cord and heavy duty plug, dummy plug and leather carrying case shall be provided for each guard. The guard on each tour normally inserts the dummy plug in every station consecutively. This causes an indicating drop on an annunciator at the desk to come into view for each station, and also records the time of the visit on a chart. The guard may converse with the chief guard from every outlying station by connecting the handphong. The chief guard may call a guard on a tour by operating a tour control key at the desk which lights all pilot lamps on the stations for that tour. The guard answers the chief guard by connecting the handphong.

**C. Central station system:** (Similar to system A except that the recording is transmitted to a central station operating company.)

### 7.63 Equipment.

**Aa. Install at the first and last stations in the tour an electrically operated transmitter consisting of clock mechanism and contact springs mounted behind faceplate having an opening for insertion of tour key. At all other locations install an intermediate mechanical station. Provide one tour key for each guard or tour.**

**Ab. Install in superintendent's office a metal case tour recorder with synchronous motor driven clock and magnetically operated printing mechanism complete with paper tape and rollers. Recording shall indicate "start" or "finish" of tour, and time of visit. Each tour shall have separate terminal connections.**

**Ba. At each location shown install a watchman's station consisting of a cast metal plate having mounted thereon a heavy duty jack and a bullseye with lamp and receptacle complete with backbox.**

**Bb. In guard room install a metal desk with turret having mounted**

**thereon a central panel with an electrical reset annunciator equipped with ———drops (name number based on one drop for each station on a tour), route control keys and pilots, loudspeaker and handphong with cord and plug. One side panel shall contain the synchronous motor driven chart recorder. The other side panel shall contain the charging meter and control equipment for the battery. The lower rear section shall contain all terminal strips for the circuit wiring.**

**Bc. In machine room in basement install a complete storage battery and rack with dry plate rectifier charger arranged for trickle and booster charging. The voltage and the size of the battery cells shall be as recommended by the manufacturer of the system.**

**Ca. (Same as paragraph Aa.)**

**Cb. Install in superintendent's office a metal cabinet with hinged door and equipped with lock and keys. This cabinet shall contain the central station transmitter complete with control and test equipment and terminal strips to extend wiring.**

### 7.64 Terminal strip cabinets.

Furnish and install where shown on plans, flush steel cabinets with hinged doors equipped with lock and keys. The terminal strips shall have sufficient pairs of terminals for all conductors plus 10 spares.

### 7.65 Operating current.

The system shall operate from (A) 115 volts 60 cycle ac, (B) storage battery with voltage and current output in accordance with the manufacturer's recommendation, (C) central station operating company's source of current, (A, B) derived from separate circuit from nearest lighting panel.

### 7.66 Wiring.

All wiring shall be run in approved conduit in the same manner as for the lighting system. The wires for the signal circuits shall be color-coded and rubber covered. (A) Two No. 14 B & S gauge, (B) Section and common signal wires No. 16 B & S gauge with telephone wires twisted No. 19 or No. 22 B & S gauge, (C) wiring as recommended by the central station operating company.

## 7.7 Electric Clock Systems

**A. Synchronous, single, motored clocks, no central control.**

**B. Synchronous, dual motored**

**clocks, central control (1) Manual (2) Automatic.**

**C. Synchronous master and secondary clocks.**

**D. Minute impulse master and secondary clocks.**

**E. Electronic controlled clocks.**

### 7.71 General.

Furnish and install an (trade name and/or number) electric clock system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left in first class operating condition.

### 7.72 Operation.

**A. Synchronous single motored clocks, no central control system:** At each location where shown there shall be a single synchronous motored clock, connected on a separate circuit (or plugged into hanger receptacle) with not more than 25 connected thereto. All clocks shall operate individually from the lighting circuit. Clocks shall be provided with a manual reset device.

**B. Synchronous dual motored clocks, central control system:** At each location where shown there shall be a synchronous motored clock with two motors. In supervisor's office there shall be (1) a manual control unit, (2) an automatic control unit, (1, 2) which shall correct the time on all clocks simultaneously, in the event of an interruption of current. Normally the clock movements operate on the standard speed motor. When clocks are "slow" the high speed motor advances the clocks to the correct time. When the correct time has been established, the normal speed motors are returned to the circuit.

**C. Synchronous master and secondary clock system.** At each location where shown there shall be a single synchronous motored clock with time synchronizing movement. In supervisor's office there shall be an automatic synchronous motored master clock which shall correct the time on all outlying clocks once each hour and after an interruption of current. The normal correction shall be at some pre-determined point, whether "fast" or "slow".

**D. Minute impulse master and secondary clock systems:** At each location where shown there shall be a secondary minute impulse clock. In



supervisor's office there shall be a master clock which shall transmit electrical impulses once each minute to all secondary clocks, time stamps and card time recorders and advance them one minute at a time under normal conditions. The master clock shall correct the secondary clocks once each hour at some pre-determined point, whether "fast" or "slow".

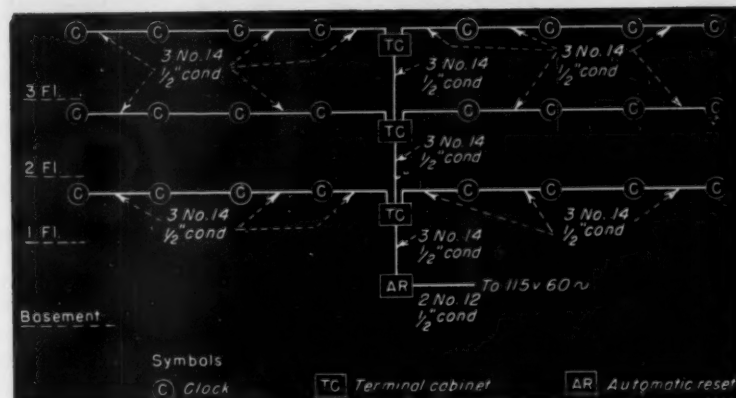
E. Electronic controlled clock system: At each location where shown there shall be an electronic controlled secondary clock. In supervisor's office there shall be an electronic master clock which shall transmit radio impulses once each hour to all secondary clocks. Upon receipt of the hourly supervisory impulse, each secondary clock initiates its own self-corrective cycle, whether "fast" or "slow". The high frequency current shall be transmitted from the master clock to fixed frequency electronic receivers in the secondary clocks over direct wire connections fully metallic circuit. (The secondary clocks may also be connected at any outlet if desired.)

### 7.73 Equipment.

Aa. Install in each room a flush (or surface) synchronous motored ac clock with single motor having a 12-in (or 8- or 15-in) dial in round spun metal case with convex cover glass, complete with outlet box (or hanger plate outlet with cord and plug). In corridors install a double face wall bracket mounting (or ceiling suspended) clock with 15-in (or 18-in) dials in round spun metal case having metal bracket wall supports (or chain supports) with convex cover glasses complete with backbox. Clocks shall be equipped with manual reset device.

Ba. Install in each room a flush (or surface) synchronous motored ac clock with two motors having a 12-in (or 8- or 15-in) dial in round spun metal case with convex cover glass, complete with backbox. In corridors install a double face wall bracket mounting (or ceiling suspended) clock with 15-in (or 18-in) dials in round spun metal case having metal brackets wall supports (or chain supports) with convex cover glasses complete with backbox.

Bb. In supervisor's office install (1) a manual control plate having mounted thereon two tumbler switches, one for control of normal speed motors and one for control of high speed motors, and current interruption indicating pilot lamp, (2) an



Riser layout, synchronous dual motored clock system.

automatic control panel in flush (or surface) steel cabinet with hinged door equipped with locks and keys. The panel shall contain all control equipment for operating the normal and high speed clock motors.

Ca. Install in each room a flush (or surface) magnet operated secondary with one motor and time corrective movement having a 12-in (or 15-in) dial in round spun metal case with convex cover glass, with backbox. In corridors install a double face wall bracket mounting (or ceiling suspended) Graham dead beat escapement clocks with 15-in (or 18-in) dials in round spun metal case having metal bracket wall supports (or chain supports) with convex cover glasses complete with backboxes.

Cb. In supervisor's office install a synchronous motored master clock with 12-in dial, relays for each secondary clock circuit of 25, with hourly corrective equipment, all enclosed in surface (or flush) metal case.

Da. Install in each room a flush (or surface) magnet operated secondary clock with 12-in (or 15-in) dial, in round spun metal case with convex cover glass complete with backbox. In corridors install a double face wall bracket mounting (or ceiling suspended) clocks with 15-in (or 18-in) dial in round spun metal case with metal bracket supports (or chain supports) with convex cover glasses, complete with backbox.

Db. In supervisor's office install a master clock with minute impulse 60 beat Graham dead beat escapement movement magnet (or motor) wound, with mercurial (invar or bob) pendulum to keep correct time within 10 seconds (bob 30 seconds) per month, 12-in dial, relays for each

secondary clock circuit of 25, with hourly correction equipment, all enclosed in surface (or flush) wood (or metal) case.

Dc. In machine room install a stable voltage rectifier having an output of 24 volts dc with current sufficient to operate all clocks on the system.

Ea. Install in each room a flush (or surface) electronic controlled secondary clock complete with receiving and amplifying equipment and synchronous motor movement. Clocks shall have 12-in (or 15-in) dials, in metal cases with convex cover glasses complete with backboxes. In corridors install double face bracket mounting (or ceiling suspended) clocks with 15-in (or 18-in) dials in metal cases with metal bracket supports (or chain supports) with convex cover glasses.

Eb. In supervisor's office install a master electronic clock with high-frequency transmitting equipment and selective corrective apparatus to regulate secondary clocks and a synchronous motor for operating the train gear of the clock. This shall be enclosed in a metal case with convex cover glass and 12-in (or 18-in) dial.

### 7.74 Terminal strip cabinets.

Furnish and install where shown on plans, flush steel cabinets with hinged doors equipped with lock and keys. The terminal strips shall have sufficient pairs of terminals for all conductors plus 10% spares.

### 7.75 Operating current.

The system shall operate (A,B,C,E) directly from 115 volts 60 cycle ac (D) a stable voltage rectifier power supply having an output of 24 volts dc (A,B,C,D,E), derived from a separate circuit from the nearest lighting

panel. Circuit switch shall be appropriately marked or held to prevent accidental operation.

#### 7.76 Wiring.

All wiring shall be run in approved conduit in the same manner as for the lighting system. The wiring to all clocks shall be No. 14 B & S gauge. (A,D,E) Two wires are required for the circuits and (B,C) three wires.

#### 7.77 Finish.

All wood finishes of master clocks shall match surrounding woodwork. Metal cabinets shall be standard finish (or have prime coat). Clock cases shall be standard finish (or be finished as directed by the architect).

### 7.8 Program Signal Systems

A. Synchronous, single circuit, 1 minute interval.

B. Synchronous, multi-circuit, 1 minute interval.

C. Minute impulse, single and multi-circuit, 1 minute interval.

D. Electronic, single and multi-circuit, 1 minute interval.

#### 7.81 General.

Furnish and install an (trade name and/or number) electric motored program instrument as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left in first class operating condition.

#### 7.82 Operation.

A. Synchronous, single circuit, 1 minute interval: In office where shown there shall be a self starting synchronous motored program instrument, connected and supplied with current from a separate circuit from the nearest lighting panel. This instrument shall be of the metal drum or disc type and shall control a single circuit of audible signals on any one minute interval over a 24-hour period. A calendar device shall be provided to automatically silence the signal circuit during any desired two-hour period. A manually operated switch shall be provided to silence signals as desired. A pushbutton switch shall be provided to operate the signals manually as desired. The length of the signal shall be controlled by means of a duration contact.

B. Synchronous, multi-circuit, 1 minute interval: In office where shown there shall be a self-starting synchronous motored program instrument, connected and supplied with current from a separate circuit from the nearest lighting panel. This instrument shall be of metal drum or disc type and shall control two (three, four, five or six) circuits of audible signals on any one minute interval over a 24-hour period. A calendar device shall be provided to automatically silence the signal currents during any desired two-hour period. A manually operated switch shall be provided to silence each signal circuit as desired. A pushbutton switch shall be provided to operate each signal circuit as desired. Two duration contacts shall be included for regulating the length of the signals, one to control all interior signals and one to control all exterior signals. The front of the cabinet shall have a timepiece fitted into same.

C. Minute impulse, single and multi-circuit, one minute interval: In office where shown there shall be a minute impulse type of program instrument installed in same cabinet with the master clock (or mounted adjacent thereto) and connected and supplied with current now energizing master and secondary clock system. The instrument shall be of the metal disc type and shall control (one, two, three, four, five or six) circuits of audible signals on any one minute interval over a 24-hour period. A calendar device shall be provided to automatically silence the signal circuit (or circuits) during any desired six-hour period. A manually operated switch shall be provided for each signal circuit for silencing as desired. A pushbutton switch shall be furnished for each signal circuit for manual operation as desired. Duration contacts shall be furnished (one for single circuit, two for multi-circuit) for control of time on signals.

D. Electronic, single and multi-circuit, one minute interval: In office where shown there shall be an electronic type of program instrument installed in same cabinet with electronic master clock and connected and supplied with current now energizing the master clock. The instrument shall be of the metal type and shall control one (two, three or four) circuits of audible signals, wired or unwired, on frequencies assigned on any one minute interval over a 24-hour period. A

calendar device shall be provided to automatically silence the signal circuits during any desired six-hour period. A manually operated switch shall be provided for each signal circuit. A pushbutton switch shall be furnished for each signal circuit for manual operation as desired. Duration contacts shall be furnished (one for single circuit, two for multi-circuit) for control of time on signals.

#### 7.85 Equipment.

Aa. Install where shown a flush (or surface) mounted synchronous motored ac program instrument. This shall consist of a metal drum or disc with metal plugs for setting up the time for operating a single circuit of audible signals on any minute interval. The calendar device shall be associated with the program device for silencing the signal circuit. The enclosed equipment shall be complete with a duration contact, circuit relay and reset switch. The exterior equipment shall consist of a manual pushbutton switch and a circuit silencing switch.

Ab. Install where shown a vibrating bell (four, six or ten inches) or horn (projector or projectorless) or chime (single or double note) or buzzer and connect in multiple directly to the program instrument.

Ba. Install where shown a flush (or surface) mounted synchronous motored ac program instrument. This shall consist of a metal drum or disc with metal plugs for setting up the time for operating two (three, four, five or six) circuits of audible signals on any minute interval. The calendar device shall be furnished with plugs for changing the operating periods and to silence the signal circuits on any two-hour periods. The enclosed equipment shall be complete with two duration contacts, two (three, four, five or six) circuit relays (selected as to number of program circuits) reset switch and disconnect switch. The exterior equipment shall consist of two (three, four, five or six) circuit pushbutton switches and the same number of circuit disconnect switches, with a timepiece set into hinged door.

Bb. (Same as paragraph Ab.)

Ca. Install where shown a flush (or surface) mounted magnetically operated program instrument for operation on same current supply as the minute impulse clock system. This shall consist of a metal disc with metal plugs

or inserts for setting up the time for operating one (two, three, four, five or six) circuits of audible signals on any one minute interval. The calendar device shall be furnished with plugs or inserts for changing the operating periods, and to silence the signal circuits on any six-hour period. The enclosed equipment shall be complete with one (or two) duration contacts, one (two, three, four, five or six) circuit relays (selected as to number of program circuits) reset key for magnetic movement and a disconnect switch. The exterior equipment shall consist of one pushbutton switch for each signal circuit and a timepiece set into hinged door.

Cb. (Same as paragraph Ab.)

Da. Install where shown a flush (or surface) mounted electronic type of program instrument for operation on the electronic clock system. This shall consist of a metal program instrument with adjustment for setting up the time for operating one (two, three or four) circuits of audible signals on any one minute interval. A calendar device shall be associated with the program unit and arranged for changing the operating periods and to silence the signal circuits on six-hour periods. The enclosed equipment shall be complete with two duration contacts, two (three or four) circuit relays, reset switch and disconnect switch. The exterior equipment shall consist of one (two, three or four) circuit pushbutton switches with a timepiece set into hinged door.

Db. Install where shown a vibrating bell (four-, six- or ten-inch) or buzzer for operation on a different frequency for each circuit and connect to program instrument.

#### 7.84 Terminal strip cabinets.

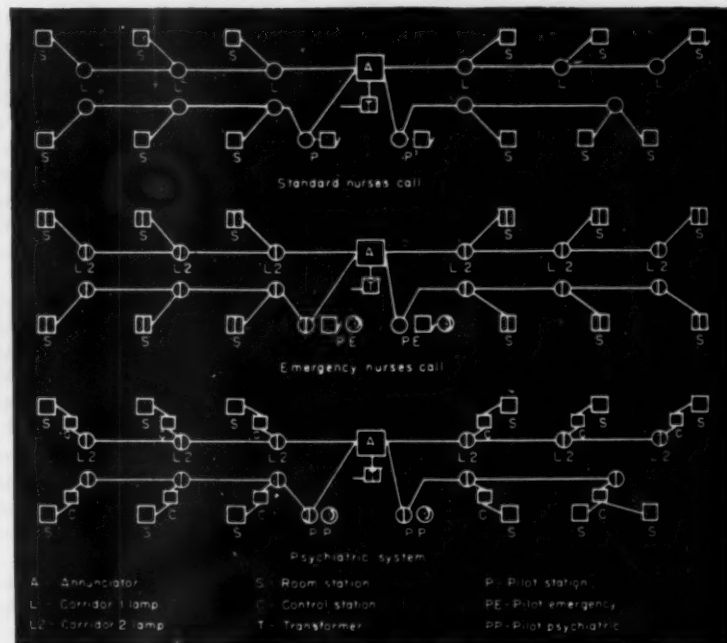
Furnish and install where shown on plans, flush steel cabinets with hinged doors equipped with lock and keys. The terminal strips shall have sufficient pairs of terminals for all conductors plus 10% spares.

#### 7.85 Operating current.

The system shall operate (A,B,D) directly from 115 volts 60 cycle ac, (C) a stable voltage rectifier power supply as recommended by the manufacturer, (A,B,C,D) derived from a separate circuit from the nearest lighting panel.

#### 7.86 Wiring.

All wiring shall be run in ap-



Layout, nurses' call system.

proved conduit in the same manner as for the lighting system. The wiring to all program instruments (A,B,D) shall be No. 14 B & S gauge directly to the nearest lighting panel and shall be connected to a separate switch, (C) shall be No. 14 B & S gauge directly to a stable voltage rectifier power supply. (A,B,C,D) one common No. 14 B & S gauge from the program instrument to all signal devices, and one section No. 14 B & S gauge from each program circuit relay to the signal devices to be controlled by each relay.

#### 7.9 Nurses' Calling System

A. Lamp annunciator. (1) Locking button. (2) Pull cord.

B. Nurse-patient communication, locking button type. (1) Portable speaker. (2) Wall speaker.

C. Nurses-patient communication. Remote automatic reset.

D. Psychiatric.

#### 7.91 General.

Furnish and install a (trade name and/or number) nurses' calling system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system shall be wired and installed in accordance with the manufacturer's specifications, and left in first class operating condition.

#### 7.92 Operation.

A. Lamp annunciator system: At each bed there shall be a calling station having a (1) detachable plug, cord and locking button, (2) toggle switch with pull cord and pendant (1, 2). A patient desiring a nurse shall (1) press the locking button, (2) pull the cord, (1, 2) which causes a lamp signal to light at the following locations: over the patient's room door on corridor side, directional pilots at intersection of corridors, pilots or annunciators in diet kitchens and utility rooms, nurses' station and supervisory office. In addition, stations in wards shall have bullseye lighted on calling station. Simultaneously there shall sound momentarily a buzzer in the pilot stations and annunciators except directional pilots. The buzzer may be sounded repeatedly by the patient if necessary. A cut-off switch shall be provided with each buzzer. All lamp signals shall remain lighted until the call is reset by the nurse at the bedside. (1) Removal of the plug accidentally or otherwise shall light the same lamp signals as if the patient had pressed the calling button, and shall cause the buzzer to sound continuously to signify that the station is out of service. To allow of removal of plugs when desired, the receptacle must also be provided with a device so that all signals may be cancelled with the plug removed. It shall be



possible to replace plug with the switch in the "off" position.

**B. Nurse-patient communication:** At each single or double bed there shall be an extension of the plate on the nurses' call station which shall contain (1) facilities for a portable speaker-microphone, (1) screened flush speaker-microphone, (1, 2). A patient desiring a nurse shall (1) press the locking button, (2) pull the cord, (1, 2) which causes a lamp signal to light, and buzzers to operate at the same points as the regular calling system, except at the nurses' station annunciator which shall be replaced by a nurses' station control keyboard unit and a power unit with amplifier. The control keyboard shall be provided with two position switches for each pair of rooms, with individual lamp signals for each room, and a molded hand-phone for conversing with the patient. It shall not be possible for the nurse to listen in on any room for supervisory purposes without operating a pilot light on the patient's station. A switch shall be provided on each room speaker-microphone to insure privacy when desired.

**C. Nurse-patient communication.** Remote automatic reset: At each single or double bed there shall be a compact self-contained flush wall station with speaker-microphone, two cord receptacles, pilot light, privacy pilot light and single cord set with detachable plug, cord and non-locking pushbutton for each bed, together with a locking relay and reset button, complete with associated backbox. Cord receptacles shall be provided with safeguard feature to initiate signal in the event of accidental cord disconnection. A patient desiring a nurse shall press the non-locking button which causes a lamp signal to light at the following locations: over the patient's room door, on corridor side, on patient's station, on lights in duty rooms and on the master station at the nurses' station. Simultaneously there shall sound momentarily a buzzer in the pilot stations and at the master station. The buzzer may be sounded repeatedly by the patient if necessary. All lamps may be extinguished at either the bedside station or at the master station.

**D. Psychiatric system:** At the entrance to each private room, ward and day room, there shall be a wall control station having a cylinder lock switch. In the private rooms there shall be a wall station with pushbuttons. In

wards and day rooms there shall be two or more wall stations as shown. By inserting and turning a key in the lock of the corridor station an attendant shall cause a clear lamp to light at the following locations: over the patient's room door corridor side, pilots or annunciators in the diet kitchens and utility rooms, nurses' station and supervisor's office. An attendant may summon assistance by operating a button in the room stations, which shall cause to be lighted a red lamp at all points also equipped with clear lamps. In addition a bell shall ring in all pilot stations and annunciators. All signals, both bells and lamps shall remain "on" until assistance arrives and the wall control station is reset by means of a key.

### 7.93 Equipment.

**Aa.** Install in all private rooms a nurses' calling station consisting of single gang metal wall plate with (1) receptacle mounted on a separate yoke and having a detachable five way plug with a single cord and molded locking button, (2) toggle switch having five contacts and single pull cord with pendant.

**Ab.** Install in all semi-private rooms where beds are not adjacent same type of stations specified for the private rooms. Where beds are adjacent provide stations with (1) single plug with two 6-ft cords and two locking buttons, (2) double pull cords and pendants.

**Ac.** Install in all wards having three or more beds, stations similar to those specified for the private and semi-private rooms, except that a bullseye complete with lamp and receptacle is to be added.

**Ad.** Install in all toilets, bath-rooms and solariums a wall type cordless station on single gang metal plate.

**Ae.** Install on each open porch or balcony a station similar to that specified for the private rooms except that it shall be weatherproof and be provided with a screw-on cover to cover the receptacle, and a rubber gasket between the station plate and the wall, complete with a cord 15 ft long.

**Af.** Install in operating rooms explosion-proof calling stations, consisting of a special cast explosion-proof backbox and cover, with operating mechanism inside of the box. The station shall be operated by an exposed plunger on the front of the cover, so arranged that calls may be

initiated or cancelled by the foot. Calls from the station shall sound all buzzers continuously in addition to lighting the lamps until the call is cancelled.

**Ag.** Install in the corridor over the door of each private room and ward, a dome type corridor lamp station. This station shall consist of a two gang metal plate having mounted thereon a glass or translucent plastic dome covering a candelabra base receptacle and lamp. The dome shall be hinged and fastened to the plate by a snap catch.

**Ah.** Install in the diet kitchens and utility rooms a pilot and buzzer station consisting of a three gang metal plate having mounted thereon a hinged glass or translucent plastic dome similar to the corridor lamp station with the addition of a buzzer and cut-off switch.

**Ai.** Install in the diet kitchens and utility rooms a bullseye pilot and buzzer station (use in lieu of dome type where sectional indications are desired) consisting of a metal plate having one bullseye indication for each ward on the floor and one common indication for all private rooms. In addition provide a concealed buzzer and a cut-off switch.

**Aj.** Install at the nurses' station on each floor a flush lamp annunciator with metal trim and hinged door with lock. There shall be contained therein the necessary number of lamps to provide one indication for every private room, ward, solarium and isolated toilet on the floor or section. Annunciator at the floor supervisor's office is to be fully equipped for the entire floor. In addition provide a concealed buzzer with cut-off switch.

**Ba.** (Add to paragraphs Aa. and Ab.) For nurse-patient communication add a molded receptacle on same plate. In addition provide a speaker-microphone of the permanent magnet type (1) in acoustically treated portable cabinet with eight-foot rubber cord and a plug, (2) behind an extended grilled plate. Privacy switch shall be mounted on (1) speaker cabinet, (2) speaker plate.

**Bd.** (Add to paragraph Ac.) For nurse-patient communication add to the wards' stations the same equipment as for the private room stations.

**Bc.** (Add to paragraph Aj.) For nurse-patient communication eliminate lamp annunciator and locate at nurses' station a control keyboard consisting of a portable desk unit con-



taining a jewel light for each room station, three-position switching keys for each pair of stations, telephone handset on cradle with press-to-talk switch on handset or cabinet terminal strip connected to flexible cable attached to flush wall box with trim, amplifier, power supply unit and directory strip.

Ca. Install in all private, semi-private rooms and wards, nurses' calling stations consisting of a compact self-contained unit with speaker-microphone behind grille, pilot light, privacy light, two cord receptacles and reset button on separately mounted yoke and separate metal faceplate to cover same, and equipped with a single six-foot cord, detachable plug and momentary contact pear push for each bed.

Cb. Same as Ad.

Cc. Same as Ae.

Cd. (Add to Af.) Mount above operating room station a speaker-microphone mounted on a two-gang plate with separate mounting yoke.

Ce. Same as Ag.

Cf. Same as Ah.

Cg. Same as Ai.

Ch. Same as Bc.

Da. Install in corridor adjacent to private rooms, wards and dayroom doors a wall control station consisting of a two gang metal plate with a multi-contact magnetic switch and cylindrical lock mounted on a separate yoke. The lock shall be master-

keyed. Fastening screws to be tamper-proof.

Db. Install inside of each private room a calling station consisting of a single gang metal plate with special momentary contact pushbutton mounted on a separate yoke. Wards and dayrooms to have two or more stations as shown on plans. Fastening screws to be tamperproof.

Dc. Install in corridor over the door of each private room, ward and dayroom a dome type corridor lamp station. This station shall consist of a two gang metal plate having mounted thereon a glass or translucent plastic dome covering two candelabra base receptacles and two lamps, one red and one clear. The dome shall be hinged and fastened to the plate by a snap catch.

Dd. Install in diet kitchens and utility rooms a pilot and bell station consisting of a metal plate having mounted thereon a hinged glass or translucent plastic dome covering two candelabra base receptacles and two lamps, one red and one clear together with an underdome bell.

De. Install in diet kitchens and utility rooms a bullseye pilot and bell station (to be used in lieu of the dome type where desired to have sectional indications instead of one lamp of each color as indications for an entire floor) consisting of a metal plate having two bullseyes, one red and one clear, for each ward and day-

room on the floor, and two similar common bullseyes for all private rooms, together with an underdome bell.

Df. Install at the nurses' station on each floor a flush lamp annunciator with metal trim and hinged door with lock. There shall be contained therein the necessary number of red and clear lamps for each private room, ward and dayroom on the floor or section. In addition provide a concealed underdome bell. Finishes to be as specified by the architect.

## 7.94 Wiring.

All wiring shall be run in approved conduit in the same manner as for the lighting system. The wiring for the signal circuits shall be color-coded and rubber covered. Feeder wires to the transformers and rectifier-amplifier shall be No. 14 B & S gauge. All signal wires shall be No. 16 B & S gauge. All wires for the audio talking circuits shall be No. 18 twisted shielded pair. Number of wires in signal circuits (A,B,C,D) in corridors four common and one section wire from each room, (A,B,C) in rooms three common and one section wire for private rooms and four common and one section wire for wards, (d) two wires. Number of wires in audio circuit (B,C) one twisted shielded pair, (C) one single wire for privacy feature.

# 8.0 Lighting

The lighting in a well planned lighting system is functional, and is usually an integral part of the architectural and decorative treatment in most structures. Thus the lighting result must be planned carefully, and all luminaires, light source types and sizes, and lighting equipment and devices must be judiciously selected to accomplish the desired lighting effects and lighting results as planned. Because of the scope of modern lighting practice and of the wide variety of light sources and lighting equipments available, the success of the final installation in providing the exact lighting result desired requires that all light sources and lighting equipment be provided and installed exactly as selected and specified. To insure that











this is done the designer (architect, engineer) should prepare a specific and detailed lighting specification complete with lighting plans and detail drawings where necessary.

Lighting equipment is normally classified under two broad headings: 1) Luminaires—individual lighting fixtures or units, reflectors, etc; and 2) Lighting Equipment—components and lighting devices, such as wiring channels, strip lighting, cove lighting, diffusing panels and louvers, etc., other than luminaires.

All luminaires, for fluorescent, incandescent or mercury vapor light sources, may be classified under one of five basic types, based on their light distribution characteristics: 1) direct—D; 2) semi-direct—SD; 3) general dif-

fuse or direct-indirect—G; 4) semi-indirect—SI; and 5) indirect—I (See Table "Lighting Systems Classification"). Standard specification paragraphs for fluorescent luminaires of these five types are given below (Section 8.3) and similar specification paragraphs can be prepared easily by the specification writer for luminaires of each of these five types using either incandescent or mercury vapor light sources, or can in most instances be obtained direct from the manufacturers of such luminaires. Standard specification paragraphs for Type D industrial reflector units for all three light sources are also given below (Section 8.5) covering the usual reflector type units normally used for industrial lighting purposes.

## LIGHTING SYSTEM CLASSIFICATIONS

SYMBOL	Type D	Type SD	Type G	Type SI	Type I
UP	0-10%	10-40%	40-60%	60-90%	90-100%
					
					
DOWN	90-100%	60-90%	40-60%	10-40%	0-10%
TYPE	Direct	Semi-Direct	General Diffuse	Semi-Indirect	Indirect

Lighting equipment other than luminaires varies so widely in types and application that no effort is made here to provide standard specification paragraphs for this type of equipment. Where such equipment is specified, for example, in cove lighting or in special luminaires, the specifier should detail the equipment on the drawings and prepare special specification paragraphs which describe the equipment in detail.

Luminaires of the five basic types vary widely in quality, design and mechanical features, materials, metal thicknesses, brightnesses, finishes, etc. For this reason, it is desirable that the specifier indicate specifically and in detail the exact luminaires selected for each area of a lighting project. This may be done under any one of the following methods:

1. Use a lighting equipment manufacturer's name, trade name and/or catalog number for the exact luminaires wanted.

2. Give a description of the physical and photometric (light distribution) features of the exact luminaires wanted.

3. Describe the lighting result or illumination performance required.

In using method 1 above, the architect or specifier usually invites trouble unless specific limitations are placed upon the bidder at the time the original bid is submitted. Use of common phrases such as "equal to", "similar to", etc. are no assurance to the architect, specifier or owner that equipment comparable to that specified will be furnished.

Many engineers have given consideration to a performance type of specification, method 3 above, but it is seldom used because of difficulty experienced in writing a suitable specification which is workable. It is not covered herein.

Method 2 seems to be the preferred way of writing lighting specifications, and this specification herein is based primarily upon this method, which can also be combined with method 1.

### 8.1 General Conditions

Some of the subjects to be considered include: scope of work, general, drawings, material and workmanship, spinnings and castings, finishes, wiring and tests.

#### 8.11 Scope of work.

A typical paragraph conformed to the project will solve this need, and should read approximately as follows:

**The work covered by this specification includes the furnishing of all labor, materials, equipment and the installation of all luminaires, lighting equipment and components as shown on the plans and as listed in the "Schedule of Lighting Equipment" and as specified herein.**

#### 8.12 General.

Scope and intent of a typical paragraph are illustrated by the following:

**All luminaires and lighting equipment shall be delivered to the building complete, including canopies, suspensions of proper length, hickeyes, casings, sockets, holders, reflectors, ballasts, diffusing materials, louvers,**

**plaster frames and recessing boxes, etc., all wired and assembled. All luminaires and lamps shall be installed by the electric wiring contractor (lighting contractor) as provided for under the general provisions of the electrical specification.**

#### 8.13 Drawings.

When special lighting equipment other than standard catalog items are specified, drawings should be called for as follows:

**Full size shop details of special luminaires or lighting equipment, where called for in the specifications, shall be submitted to the architect (engineer), and when approved they shall be returned with contract authorizing fabrication of the equipment to be furnished.**

#### 8.14 Materials and workmanship.

Following is a typical paragraph:

**All materials shall be new and of the best grade of approved manufacturing standards and all workmanship shall be first class such as shall produce fixtures of a high character and fine finish of the type specified.**

#### 8.15 Spinnings, castings, etc.

When suspension type luminaires are involved, the following paragraph will cover workmanship on miscellaneous parts:

**Canopies, holders, etc., shall be true and even without ridges, dents, or imperfections, and shall be not less than .020 (.022, .026, etc.) in thickness at any point.**

**Casings shall be seamless tubing**

drawn not less than .05 inch thick if used as support and shall terminate in a self-aligning swivel connection permitting a 20° rotation.

Casings shall have suitable 3/8-in. hickey and iron nipple with running thread to permit correct fitting and adjustment of canopy to luminaire and ceiling.

### 8.16 Finishes.

Either standard or special finishes should be specified as wanted:

The finish on all luminaires shall be satin aluminum (baked white enamel, etc.) equal in quality to manufacturers' standard finish, unless otherwise noted in these specifications or in the "Schedule of Lighting Equipment".

### 8.17 Wiring.

Insure safe wiring with a paragraph similar to the following:

Luminaires having medium base sockets shall be wired with not smaller than No. 16, and mogul sockets with not smaller than No. 14, Type AF asbestos covered wire in accordance with the latest requirements of the National Electrical Code. Fluorescent luminaires shall be wired with not smaller than No. 16 Type AF asbestos covered wire. No splice or tap shall be located within an arm, stem, or chain. Wire shall be continuous from splice in outlet box of the building wiring system to lamp socket, or to ballast terminals in fluorescent luminaires.

### 8.2 Optional Equipment

The architect or specifying engineer has a double responsibility with his client when he specifies a lighting installation. First, he must provide for adequate lighting of proper quality for the seeing tasks involved, with suitable luminaires or lighting equipment, made of quality materials consistent with the structure in which used. Second, he should obtain this equipment at the lowest price possible consistent with the quality of the equipment furnished. Thus specifications should be sufficiently tight to insure that lighting equipment of the exact type and quality specified is furnished, but should also have some provision to insure that the various bids are competitive. Since luminaires made by different lighting equipment manufacturers may look alike while varying considerably in quality of mate-

rials used, in design and maintenance features, and otherwise, the lighting specification should describe very clearly and exactly what is required, and should be very specific on all details of construction, design, and lighting performance. If it is intended that bidders be permitted to bid on alternate, or optional equipment, or that the electrical contractor who has been awarded the electrical work be permitted to submit alternate or optional lighting equipment for approval after the contract has been let, the exact basis on which the alternate bid, or the submission of alternate equipment for which final approval is to be made, should be spelled out in detail in the specification. These provisions should, of course, conform to the details of paragraph "1.62 Substitutions", under "1.0 General Conditions", or should be explicit in the fact that the provisions set forth in the specifications covering the lighting equipment supersedes the "General Conditions".

A typical paragraph on substitutions follows:

Luminaires or lighting equipment differing from that specified may be included in original bids by any bidder, or may be submitted for approval of the architect and engineer after the contract has been let; provided, 1) that in submitting his original bid, the bidder also submits an alternate proposal based on furnishing and installing the proposed substitute as well as his base bid on the exact luminaires and lighting equipment as specified; or 2) that the contractor may request in writing within (ten) days after the award of the contract, to be allowed to make the substitution, and quote the price differential which will apply in case the substitute equipment is approved. In either event, the bidder,

or the contractor who requests approval of a substitute, for the complete job or for any part thereof, shall further clearly state in writing all such differences as may exist between the lighting equipment specified and the alternate equipment proposed for substitution, and shall further strictly adhere to all essential light distribution requirements of the specified types of lighting equipment. The contractor who requests permission to make such substitutions shall further meet all requirements of the provisions outlined in paragraph "1.62 Substitutions" (see "1.0 General Conditions").

If the luminaires or lighting equipment offered under this provision are, in the opinion of the architect (engineer, owner) equal to or better than that specified, or the price differential is such that the alternate equipment is considered a better investment, then the alternate will be given consideration. Where a statement of such departures is not made with the original bid, or where a request in writing for permission to furnish and install a substitution is not received within the specified time limit, it will be understood that the luminaires or lighting equipment will be furnished in strict accordance with this specification.

### 8.3 Fluorescent Luminaires

#### 8.31 General.

The following specification paragraphs cover the five basic types of fluorescent luminaires classified according to their light distribution output as described above. These paragraphs have been prepared for fluorescent luminaires only, since these are the types most commonly specified and used today. At least three lighting equipment manufacturers can supply any one of the five basic types

### SCHEDULE OF LIGHTING EQUIPMENT

Location	Quantity	Type No.	Type	Light Source			
				Lamps per Unit	De- scrip- tion	Watts per Lamp	Suspension Length Ft. — In.
First Floor							
Entrance Lobby	6	A	Inc	4	PS30	200	Recessed
Guard's Office	4	B	FI	4	48" T12	40	Recessed
Corridor	2	C	FI	10	72" T8	51	In Coves
Office No. 100	12	D	FI	10	48" T12	40	2 Ft.-3 In.



**GENERAL LIGHTING**

**COMMERCIAL**

- Stairways — Dining Areas—Hotel Lobbies—Food Markets—Laboratories — Show Cases
- Corridors — Store Aisles—Beauty Parlors — Auto Showrooms — Wall Cases — Feature Displays
- Stock Rooms — Art Galleries (General) — Specialty Shops — Art Displays
- Theatres — Waiting Rooms—Kitchens—Department Stores—Hospital Examination
- Auditoriums — Lobbies—Word Rooms—Mailing—Exhibition Halls

**Spotlighting**

- Minor Surgery
- Dental Surgery

**INDUSTRIAL**

- Storage Garages
- Loading Docks — Rough Testing — Punch Presses
- Furnace Rooms — Sheet Bar Mills—Leather Cutting — Slitting — Wood Carving — Finishing — Extra Fine Finishing
- Outside Work Areas — Active Storage — Rough Machine Work — Fine Assembly — Canning — Examination
- Rough Manual Tasks — Clay Products — Medium Assembly
- Foundries

**Inspection**

- Bench Work — Book Binding — Production
- Machining — Auto Assembly Line
- Fine Inspection

**Color Identification**

**OFFICES**

- Stairways
- Corridors — Reception Rooms—Private Offices—General Deskwork — Vortyping
- Lobbies — Conference Rooms — Typewriting — Drafting Rooms
- Locker Rooms — Manual Training — Study Halls — Sight Saving Rooms
- Class Rooms — Sewing Rooms

**SCHOOLS**

**Recommended Footcandle Values Shown Here Were Taken From The IES Lighting Handbook, Second Edition, 1952**

Arbitrary Scale, But Based on Assumption that Any Visual Task that is Twice as Difficult as Another Requires Twice as Much Light for Equal Seeing Ease.

Seeing Tasks Requiring 20 Footcandles

ILLUMINATION IN FOOTCANDLES

DEGREE OF SEVERITY OF THE VISUAL TASK

Logarithmic Scale

Task Category	Task	Recommended Footcandle Value	Severity Level
Commercial	Stairways	6	Rough
	Corridors	12	Casual
Industrial	Storage Garages	25	Ordinary
	Outside Work Areas	50	Average
Offices	Locker Rooms	100	Difficult
	Class Rooms	200	Very Difficult
Schools	Stairways	400	Extremely Difficult
	Corridors	800	Most Difficult



as covered in these specifications, and many manufacturers can supply one or more of the five types. The specification details in these paragraphs have purposely been made fairly rigid. If less rigid specifications are wanted, the specifier should conform the suggested covering paragraph with details relating to the specific luminaires he wants used, or is willing to accept.

### 8.32 Type D luminaires.

(Type D luminaires are direct lighting, and refers to systems where practically all of the illumination on the seeing tasks is directed from the luminaires in angles below the horizontal).

Luminaires shall be of the direct recessed troffer type, and of such design that the entire light output is in the 0°-90° zone. Luminaire shall be applicable to ceiling surfaces of plaster (metal, or the various types of acoustical tiles) and be wholly (partially) recessed above the finished ceiling as individual units (continuous rows) as shown on drawings. Troffer shall be of the open type (or, equipped with hinged frame containing metal louvers, or baffles, translucent diffusing glass, prismatic glass, or plastics in flat or curved sections) as indicated on plans and listed in the "Schedule of Lighting Equipment".

The wiring channel shall be of not less than No. 20 gauge steel with flanged top so that supporting brackets may be attached at any point along its length. Each 48-in. or 96-in. section shall house all ballasts, sockets, and starters (omit starters for slimline) rigidly mounted to No. 18 gauge steel stiffening straps accessible without the use of tools by lowering reflector. Detachable closed and flanged reflectors shall be of not less than No. 20 gauge steel 48-in. OA chemically treated to resist corrosion and to prepare a base for the application of high temperature white baked enamel finish having a reflection factor of not less than 80%. Entire assembly shall be furnished with all necessary mounting, brackets, hangers, clips, etc., at intervals most suitable to the structural ceiling design.

Luminaire shall be designed for and accommodate two standard 40-watt T12 Type F fluorescent lamps (two 40-watt T17 Type F fluorescent low brightness lamps, two 96-in. T12 slimline fluorescent lamps, etc.), all as indicated on the drawings and listed in the "Schedule of Lighting Equipment".

Where troffers of the low brightness types using aluminum reflectors are required, or with other features differing from the above specifications paragraph, the specifications should be altered accordingly. Any manufacturer of lighting equipment of this type will also furnish specification paragraphs covering his own specific equipment.

#### 8.321 Hinged door frame.

When troffers are equipped with hinged frames, or other special devices, these should be specified in detail. Typical paragraph follows:

The removable door frame with mitred corners and reinforcing cross member shall be rigidly welded to maintain close fitting tolerances through installation and maintenance handling. The door shall seat entirely within the reflector with no light leakage and shall hinge from the reflector for servicing and cleaning. All exposed trim shall be chemically treated to resist corrosion and to prepare a base for the application of a high temperature grey (satin aluminum, white) baked enamel prime coat. Final finish shall be as indicated (in the painting contract, in the "Schedule of Lighting Equipment", etc.)

#### 8.322 Door frame accessories.

Detailed specifications covering important accessories, such as louvers, control lenses, diffusing media, etc. insures good final lighting results and aids in obtaining the exact lighting equipment specified.

**Metal Louvers**—Louvers shall be of eggcrate design providing 30° shielding crosswise and lengthwise and shall be stamped from not less than No. 22 gauge steel (aluminum) rigidly assembled to withstand all normal handling and servicing. Louver shall be held in the door frame by screwless spring type retainers. Louvers of steel shall be finished in high temperature baked white enamel. (Etched aluminum louvers shall have all surfaces protected by a suitable coating or process). Maximum brightness in the shielding zone (30° to 90° crosswise) shall not exceed 550 footlamberts and lengthwise shall not exceed 452 footlamberts.

**Glass and Plastic Enclosures**—Glass (or plastic) enclosures shall be opalescent diffusing glass (prismatic glass lenses, or any of the styrene resin or acrylate plastics) and shall further be dimensionally and chemically stable

over a wide range of temperature, humidity and atmospheric conditions. The maximum permissible brightness (of any enclosing media) at any point above 60° from the vertical shall not exceed 450 footlamberts.

### 8.33 Type SD luminaires.

(Type SD luminaires are semi-direct lighting, and refers to systems in which from 60% to 90% of the light output from the luminaires is directed below the horizontal). A typical specification paragraph follows:

Luminaires shall be of the semi-direct type such that approximately (10% to 30%) of the light output is in the 90° to 180° zone, and (60% to 90%) in the 0° to 90° zone. Luminaire shall be pendant (or surface) mounted. The overall efficiency in percent of bare lamp lumens shall be not less than (76%). The maximum brightness at any angle within the shielded zone shall not exceed 650 footlamberts. Moulded styrene resin (acrylate plastics, or diffusing glass) panels in combination with not less than No. 22 gauge durable etched and lacquered aluminum (or steel) louvers, finished in high temperature baked white enamel, shall constitute the shielding assembly. The louver assembly shall be a removable unit, firmly supported from the wiring channel and hinged from either side for simple and easy maintenance.

Wiring channel, reflectors, cover, and end plates shall be of not less than No. 20 gauge steel, chemically treated to resist corrosion and in preparation for finishing, and shall be finished in high temperature white baked enamel. All exposed metal reflecting surfaces shall have a reflection factor of not less than (80%). Luminaires shall be designed for individual or continuous row mounting, and shall be for two (three, four) standard Type F fluorescent lamps (rapid start 40-watt, or Type T12 slimline, fluorescent lamps) as indicated on the drawings and listed in the "Schedule of Lighting Equipment". All wiring shall be not less than No. 16 Type AF fixture wire. Ballasts shall be of the high power factor multi-lamp type and starters (omit starters for rapid start and slimline lamps) shall be of the lock-out manually reset type. Entire luminaire and all component electrical parts shall be listed by the Underwriters' Laboratories as meeting National Electrical Code requirements.

# LUMINAIRE MOUNTING AND SPACING

## COMMERCIAL

## INDUSTRIAL

	Direct		Semi-Direct	Semi-Indirect		Indirect	Spread	Concentrating	
Mounting Height of Luminaire									
Ceiling Height for Indirect and Semi-Indirect Luminaires	D		SD	SI		I			
Dimensions in Feet	Usual Spacing Between Units	Max. Spacing Between Units	Spacing* from Walls	Spacing Between Units	Spacing* from Walls	Length of Suspension	Maximum Spacing¹ (ft.)		
8	7	7½	3	9	3	1-3	Mounting Heights Above Floor	Spacing Between Units²	
9	8	8	3	9½	3	1½-3		Spread	Concen't.
10	9	9	3½	10½	3½	2-3	15	12	—
11	10	10½	3½	12	3½		16	12	—
12	10-12	12	4	14	4	2½-4	18	18	—
13	10-12	13	4	15	4	3-4	20	20	—
14	10-13	15	5	17	5		22	20	—
15	10-13	17	5	19	5		24	23	16
16	10-13	19	6	21	6	4-5	26	25	17
18	10-20	21	6	23	6		28	30	18
20 or more	18-24	24	7	26	7	4-6	30 or more	30	20

\*Spacings apply where desks or benches are next to wall, otherwise one-half the spacing between units is satisfactory.

<sup>1</sup>Units may have to be spaced closer to obtain desired illumination values.

<sup>2</sup>Where benches or machines are next to wall, spacing from wall should not exceed ½ spacing between units. Otherwise ½ unit spacing is suitable.

### 8.34 Type G luminaires.

(Type G luminaires are of the direct-indirect type, and refers to systems where the illumination is of general diffuse character). A typical specification paragraph for this type luminaire follows:

Luminaires shall be of the direct-indirect type, such that approximately (45%) of the light output is in the 90° to 180° zone, and approximately (55%) is in the 0° to 90° zone, with not more than (7%) in the 60° to 90° zone. Luminaires shall be pendant mounted, with overall suspension length as listed in the "Schedule of Lighting Equipment". Overall efficiency in percent of the bare lamp lumens shall be not less than (80%). The maximum brightness in the shielded zone (30° to 90°) shall not exceed 550 footlamberts. Maximum brightness in the shielded zone (30° to 90°) lengthwise shall not exceed 452 footlamberts.

Plastic (or glass) side panels shall

be curved outwardly and so located on the luminaire that no part of the lamp extends above the upper edge of the panels. Plastic panels shall be ribbed extruded polystyrene, dimensionally and chemically stable over a wide range of temperature, humidity, and atmospheric conditions. Brightness of side panels shall not exceed 300 footlamberts. Panels shall be readily removable for maintenance without the need for tools.

End plates and wiring channel shall be die stamped of not less than No. 20 gauge steel. Suitable connector straps shall be provided when luminaires are to be installed in continuous rows. All channels and end plates shall be chemically treated to resist corrosion and for painting and shall be finished in high temperature white baked enamel. Channel shall be so constructed as to totally enclose the ballast and wiring. All exposed metal reflecting surfaces shall be finished in high temperature baked

semi-gloss white enamel having a reflection factor of not less than (80%).

The bottom of the luminaire shall be closed by means of a louver assembly which shields the lamps above (34°) below the horizontal crosswise of the luminaire and (30°) lengthwise. Louvers shall be of the removable hinged (drop or swing down) type with safety chain, permitting ready access to the ballast and wiring. All wiring shall be not less than No. 16 Type AF fixture wire.

Ballast shall be of the high power factor multi-lamp type. Starters shall be of the lock-out type, manually reset. Luminaire shall be designed for two standard 40-watt Type F fluorescent lamps (two 96-in. T12 slimline, or two 40-watt T12 rapid start, fluorescent lamps etc.) as indicated on the drawings and listed in the "Schedule of Lighting Equipment".

All luminaires meeting the Type G specifications, if surface mounted, may be classified as semi-direct (Type D).

### 8.35 Type SI luminaires.

(Type SI luminaires are of the semi-indirect type, and refers to systems in which 60% to 90% of the light output from the luminaire is emitted above the horizontal). Typical specification follows:

Luminaires shall be of the semi-indirect type, such that approximately (60% to 90%) of the light output is in the 90° to 180° zone and (10% to 40%) in the 0° to 90° zone. Luminaire shall be pendant mounted. Stem suspensions shall be (27 inches) overall. The overall efficiency in percent of the bare lamp lumens shall be not less than (71%). The maximum brightness at any angle between 45° and 90° crosswise shall not exceed (150) footlamberts. Moulded plastic (or glass) reflectors shall be so located on the luminaire that no part of the lamps, ballast or ballast shield extends above the upper edge of the reflector. Reflectors shall be readily removable for maintenance without the need for tools.

Wiring channels shall be formed of not less than No. 20 gauge steel of sufficient size to provide for all necessary wiring. High power factor multi-lamp ballasts and lock-out type manually reset starters shall be mounted on the top of the wiring channel. All wiring shall be not less than No. 16 Type AF fixture wire. Complete luminaire, including ballast, wiring, lampholders and starters (omit starters on rapid start and slimline lamps) shall be listed by Underwriters' Laboratories as meeting National Electrical Code requirements.

Luminaire shall be designed for two standard Type F fluorescent lamps (two 96-in T12 slimline, or two 40-watt T12 rapid start, fluorescent lamps) as indicated on drawings and as listed in the "Schedule of Lighting Equipment".

Some luminaires having design and structural characteristics similar to those meeting the requirements for Type G direct-indirect luminaires but intended for use with four or six fluorescent lamps, because of the wider top opening, will meet the zonal distribution requirements for Type SI semi-indirect luminaires. Such units may, however, exceed the maximum brightness (150 footlamberts) specified for Type SI units. Various glassware or plastics are available which may be used in place of louvers to meet the 150 footlambert limitations.

### 8.36 Type I luminaires.

(Type I luminaires are of the indirect lighting type, and refers to systems where from 90% to 100% of the light from the luminaire is emitted above the horizontal to light the ceiling and upper side walls. The light is thus diffusely reflected from the ceiling and side walls to the work surfaces in the room below. Luminaires similar in design characteristics to Type SI luminaires, but having metal reflectors or suitable glass or plastic reflectors will meet this classification).

To specify Type I luminaires, use the specification for Type SI luminaires, altered insofar as luminaire body is concerned, and using the following paragraph to cover the indirect reflectors:

Reflectors shall be formed of not less than No. 22 gauge steel chemically treated to prevent corrosion and to form a base for finish, and finish in a high temperature white baked enamel finish with a reflection factor of not less than (80%) (or etched aluminum with Alzak finish having a reflection factor of not less than (75%)).

## 8.4 Trans-Lighted Ceilings

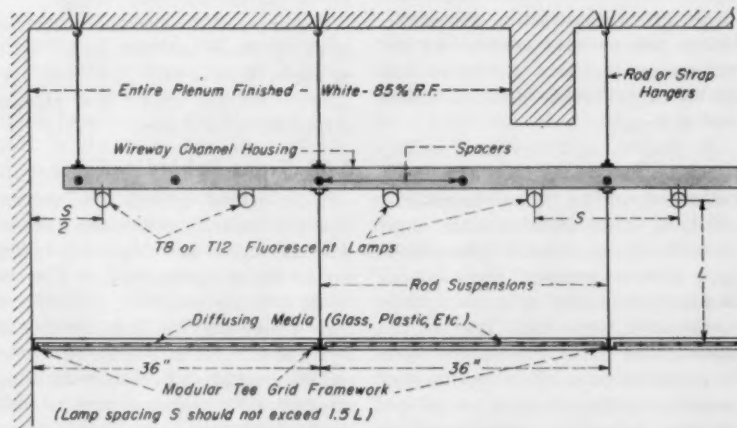
### 8.41 General.

Forging ahead in popularity in the field of lighting design and application are trans-lighted ceilings, and one of the newer trends of using large-area luminous panels which consist essentially of smaller-than-room-size panels of trans-lighted ceilings, or of self-contained large panels consisting of large moulded plastic formed panels, lamps, auxiliaries, and metal hous-

ings which serve to support the plastic panels and as a reflector.

The trans-lighted ceilings are a modern version of the old "artificial skylights", as they were called, used in many lighting installations 30 to 35 years ago. The modern versions are modern shielding and diffusing materials, and modern light sources, combined in an integrated system, whereas the earlier versions previous to the development of the fluorescent lamp used incandescent lamps in direct lighting reflectors mounted above leaded glass ceilings, or above panels of ornamental and decorative glass. The older systems were mostly ornamental in character, while the modern versions are being used to provide high quality utilitarian light for critical seeing tasks, in offices, drafting rooms, classrooms, banks, public lobbies, waiting rooms, reception areas, stores, and many other similar commercial and industrial areas, as well as for modern streamlined appearance.

From a lighting standpoint, the trans-lighted ceiling lighting system opens up a broad new approach to artistic and practical design treatments for lighting, sound (acoustic) control, climatic (air conditioning and electric heating) control, fire (sprinkler system) control, and to new concepts of flexibility and interchangeability of areas to meet changing needs of commercial and industrial organizations. These and other services, required in today's modern structures for the comfort and well being of people who occupy them, may now be integrated into the ceiling, which *Electrical Construction and Maintenance* (October 1954) has proposed as a "modular electric ceiling". Such modular ceil-



Design details for typical trans-lighted ceiling.



ing would incorporate lighting, sound conditioning, air conditioning, the sprinkler system, and other similar systems, all built to interchangeable modular dimensions, and all combined into one ceiling on a grid framework built to the same modular dimensions.

In designing and specifying a trans-lighted ceiling, it is considered desirable to give full consideration to the design features and methods of support to be used for the lamp housings, ballast and wireway channels, and diffusing media. Experience has indicated that the most satisfactory conditions obtained on installations where the electrical channel housings which support and carry all lamps, ballasts, and wiring are supported from the ceiling slab, while the T-track grid framework or similar supporting members for the diffusing elements is supported from the channel housings. This feature of design permits full integration of all parts of the lighting system by one subcontractor, under one contract responsibility. Where the large-area self-contained panel units are used, complete with metal housing and diffusing media, this problem is solved automatically through full job jurisdiction by one contractor.

Trans-lighted ceilings are classified as a direct (Type D) lighting system, since all its light output is below the horizontal of the luminaire, or below the luminous ceiling line. Since most installations are custom designed for a particular application, or specific job, the lighting specifications should be custom prepared to meet the existing solution and existing conditions of installation. Generally, standard components are combined to compose the finished custom job. The drawings should indicate insofar as possible all details of construction and installation, and be supplemented by the written specifications to insure full quality of workmanship and materials as desired.

In general, a trans-lighted ceiling lighting system comprises a hung- or suspended ceiling using translucent plastic or other diffusing material to form the ceiling, which is lighted from light sources mounted above. Also in general the entire ceiling, or a large portion of it, becomes the light source, although the trend is more and more to panel sections. For specification purposes, ceilings formed of louvers (plastics, aluminum, steel, wood or glass) are also considered here as

## COEFFICIENTS OF UTILIZATION FOR TRANSLIGHTED CEILINGS

Room Index	Plastic Diffusers	45° Plastic Louvers	45° White Metal Louvers
A	.57	.48	.42
B	.55	.48	.41
C	.52	.46	.39
D	.49	.45	.38
E	.46	.43	.36
F	.41	.40	.34
G	.38	.37	.32
H	.33	.34	.30
I	.27	.31	.27
J	.22	.28	.23

From IES Lighting Handbook, 1952 Edition.

NOTE—Values in above table are based on 75% reflectances of surfaces in plenum cavity, and 50% reflectances for walls in room below ceiling. Recent research and continued field experiences indicate CU values are dependent upon many factors, including size and shape of plenum cavity, and that wide variances from above values are possible. Thus this table should be used as a rough guide only, and more accurate data should be obtained direct from manufacturers of specific equipment under consideration.

trans-lighted ceilings, since for all practical purposes their construction, lighting characteristics and installation details are the same. For the large-area self-contained units, consisting of housings, lamps and accessories, and diffusing medium, these may be treated similar to recessed lighting troffers or other individual type of lighting units.

The quantity and quality of light produced by a trans-lighted ceiling depends upon the following factors:

1. Type and spacing of light sources.
2. Efficiency of the diffusing media.
3. Reflectances of the ceiling, side walls, ducts and other surfaces within the plenum, and in the room area below the trans-lighted ceiling.

Recommended reflectances referred to in (3) above are: side walls—50% or above; floor—30% or higher; furniture—30% or above; and plenum space—80% or higher.

### 8.42 Trans-lighted ceiling.

Trans-lighted ceilings for decorative and utilitarian purposes, acoustical correction, and to provide spaces for air ducts, piping, etc., on conventional jobs, are adaptable to both new and remodeled building structures. Being an integral part of the structure, the architect should consider detailing most of the component parts as well as the layout plans on the architectural, mechanical and electrical plans.

These details may be supplemented by the following or similar specification paragraphs modified as required by structural or other requirements on any specific installation.

The wiring contractor shall furnish and install all wiring, wiring channels, housings, mounting frames and plastic (glass) diffusing panels as called for in these specifications and as detailed on the drawings.

Method of assembly is shown on drawing No. (—). Vinyl resin flexible plastic sheets (acrylate corrugated plastic panels—give details) shall be held in place by T and U shaped channels formed of not less than No. 20 gauge steel chemically treated to prevent corrosion and as a preparation for the finish which shall be high temperature baked white enamel. The projections upon which the plastic sheets rest and slide into shall have a one-inch wide horizontal projection, as shown in the drawings. Channels shall be spaced as shown on drawing No. (—), and suspended by wire or adjustable metal straps from the building structure in such manner as may be required to maintain straight and level position. Acoustical control where called for shall be obtained by the use of hollow perforated metal fins (outline in detail any other method developed and wanted), finished in white enamel, containing a sound absorbing pad, hung at intervals from the U shaped channels, all as shown and detailed on the drawings and as listed in the "Schedule of Lighting Equipment".

Lighting wireway channels or housings shall be installed in the plenum space above the suspended plastic ceiling so that fluorescent lamps will be (27 in.) above the plastic panels, and shall be supported by metal rod supports as shown on drawings from the ceiling slab above. The spacings shall be as shown on the drawings, and the T and U bars shall in turn be supported from the wireway channels and lamp housings by steel straps approximately as shown. Contractor shall submit shop detail drawings indicating exact construction and gauges of metal housings, supports, etc.

Automatic sprinkler heads may also be mounted in the plenum above Vinyl resin plastic sheets, as approved by the Underwriters' Laboratories, Inc., and by the National Board of Fire Underwriters. Where acrylic plastics are used for diffusers, sprinkler heads may be mounted in U chan-



nels specifically designed for this purpose, or in suspended ceiling areas provided by the architect in the lighting layout design, or incorporated in the acoustical baffles (or otherwise as designed by the architect and engineer).

For acrylate plastics in corrugated, flat or moulded patterns, and for metal or wood louvers, the supporting T bars and U channels should be heavier to support the additional weight, as compared with the support members for the lightweight Vinyl resin plastic sheets.

## 8.5 Industrial Reflectors

### 8.51 General.

With few exceptions industrial lighting design is normally classified under Type D or Type SD. Different light sources may be employed—incandescent, fluorescent, or mercury vapor—depending upon the specific application, design and other considerations. To obtain uniform lighting throughout an industrial area or over a specified industrial process three basic light distributions or variations of them are obtainable from reflectors made of porcelain enameled steel, aluminum, prismatic glass, silver mirrored glass, and the self-contained reflector type of spot and flood reflector lamps. The three basic light distributions are: wide spread, medium spread (semi-concentrating), and concentrating (intensive). Specification paragraphs below cover these various types of reflectors classified first by type of light source, second by type of light distribution, and third by type of reflector material.

### 8.52 Incandescent lamp reflectors.

#### 8.521 Standard RLM reflectors.

Standard porcelain enamel steel reflectors have a spread type of light distribution, and are normally used for mounting heights up to 25 feet. A typical specification follows:

**RLM type reflectors meeting the following specifications shall be used in locations indicated on the drawings and as listed in the "Schedule of Lighting Equipment".**

Reflector shall be made of porcelain enameled steel of not less than 0.025-in. (24 gauge) in thickness, except for the 500-watt and 1000-watt sizes which shall be made of steel not less than 0.031-in. (22 gauge) thickness. The reflecting surface shall be cov-

ered with at least two coats of separately fired white porcelain enamel over a ground coat of fused porcelain enamel. The outside surface shall be covered with at least two coats of fused porcelain enamel separately fired.

The reflector shall present a continuous surface so proportioned that when used with the incandescent lamp for which designed the filament center will be cut off from view at an angle of 72.5° from the vertical axis. It shall be equipped with an integral husk containing keyless, rigid, medium socket (mogul socket for 500-watt and 1000-watt sizes) so that no other position than this can be obtained.

The reflecting surface shall have a mean reflection factor of 78% and a minimum of 76.5%. The output of the reflector shall be at least 76% of the light generated by the bare lamp with a maximum ratio of 1.55 between the maximum candlepower from 0° to 15° and the average candlepower value at 25°, 35° and 45° after subtraction of bare lamp values at corresponding values.

Female type fitting tapped 1/2-in. standard shall be provided for mounting.

(If reflectors sub-standard to RLM reflectors are acceptable, the above specification may be altered to accept such reflectors as may be considered adequate).

#### 8.522 Aluminum reflectors.

There are two general types of industrial aluminum reflectors, one for *medium spread* light distribution (normally used for mounting heights of from 20 to 40 ft) and the other for *concentrating* type light distribution (normally used for mounting heights of 35 ft and above). A typical specification follows:

**Aluminum spread and concentrating type reflectors meeting the following specifications shall be used in locations indicated on the drawings and listed in the "Schedule of Lighting Equipment".**

Reflector shall be formed of 0.064-in. sheet aluminum. It shall have a light etch and Alzak finish inside and out with a minimum reflection factor of 75%. The socket cover shall be constructed of 0.050-in. aluminum and etched outside, with a baked flat black finish inside. Large apertures shall be provided for ventilation of the socket. Mogul ventilated type socket tapped for 1/2-in. conduit shall

have a base contact of non-corrosive metal, cup shaped, to permit broad contact surface for the lamp base. The current carrying conductor to the base contact shall be laminated. Pressure on the base contact shall be maintained by a non-current-carrying spring of non-corrosive metal.

Reflector shall have an overall efficiency of not less than (—)%. Luminaire shall be approved by the Underwriters' Laboratories, Inc., and shall carry an Alzak process label or stamp.

Where reflectors are installed in atmospheric conditions of such nature that maintenance may be a severe problem, dust-tight covers may also be specified for the aluminum (or other types) reflectors. A typical paragraph follows, which would be incorporated with the reflector specification.

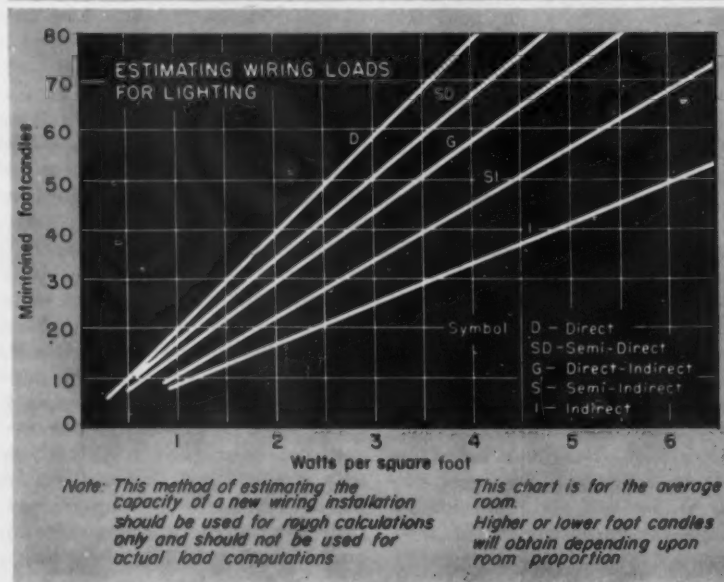
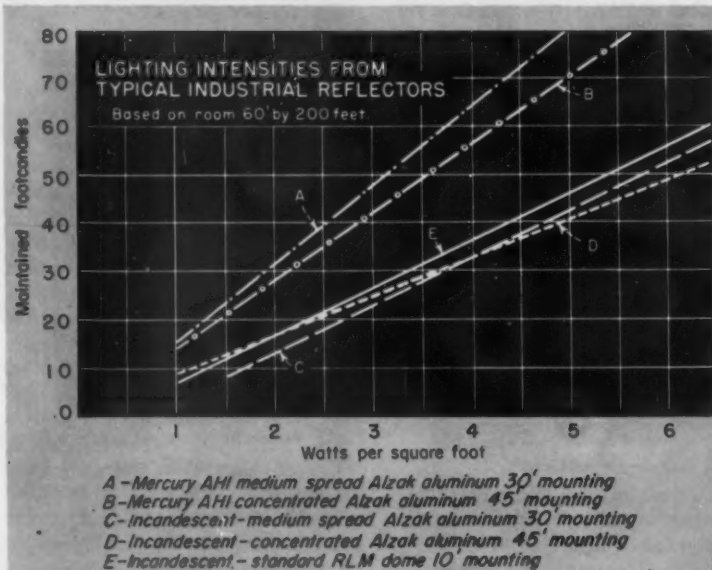
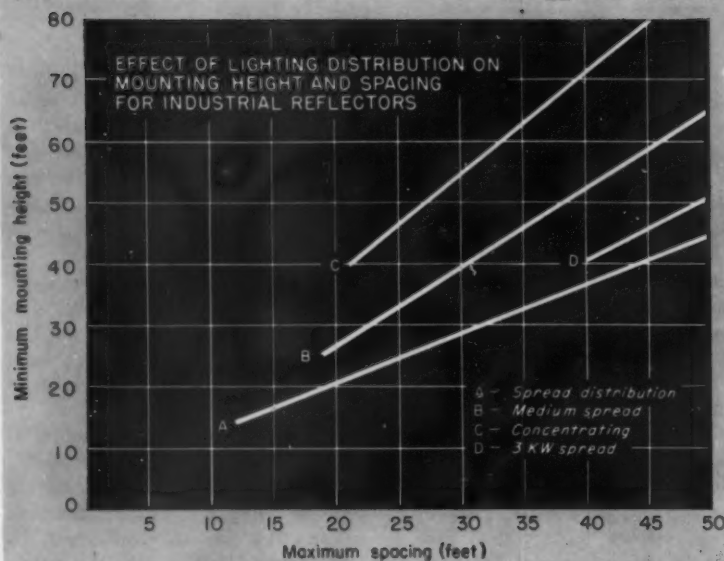
**Dust tight Covers.** The dust-tight unit shall have a standard socket cover without ventilating apertures. The reflector flange shall shield the gasket from water and dirt and provide ample gasket seating and clamping surface. The door shall be cast aluminum to provide rigid seating for a (—)-inch diameter tempered glass lens, both of which shall be furnished as part of the reflector unit. It shall hinge freely for maintenance and be secured by three wing-nut screw clamps.

#### 8.523 Prismatic glass reflectors.

Prismatic glass has long been used for industrial reflectors, using either incandescent or mercury vapor lamps, and reflectors for low, medium and high bay areas (spread, semi-concentrating, and concentrating light distributions) have been made available. Specifications for a typical unit are given below.

**Prismatic glass concentrating type reflectors meeting the following specifications shall be used in locations indicated on the drawings and listed in the "Schedule of Lighting Equipment".**

Reflector shall be pressed moulded prismatic glass, heat tempered to withstand a mechanical shock of 8-ft-pounds, and thermal shock of 100° C., and shall be complete with porcelain mogul socket having nickel plated screw shell and contacts entirely outside of reflector. Steel tripod type of holder and ring shall firmly grip the reflector from below. Tripod shall terminate in a slip ring collar to provide exact positioning of the lamp.



Glass reflector shall have a permanently spun or aluminum cover with auxiliary drip cover to protect the lamp. All ferrous parts shall be cadmium plated to resist corrosion. Fixture shall be wired with No. 12 stranded Type AVA wire. Reflector shall have an overall efficiency of not less than (—)%.

#### 8.524 Mirrored glass reflectors.

Because of its excellent qualities as a reflecting medium, silver mirrored glass has been used for industrial type reflectors, and may be specified, when desired, by the following typical specification paragraph:

Reflector shall be of crystal clear blown glass slightly corrugated to produce the exact light distribution required and to eliminate filament striations. Glass shall be free of color, bubbles, seeds and scratches. The edges shall be ground smooth and shall not be chipped or cracked. The silver reflecting surface shall be protected by a suitable backing that will withstand the heat of the lamp for which the reflector was designed without chipping, peeling, or causing the silver reflecting surface to tarnish or discolor in any way whatever. Steel tripod type holder and cast ring shall support reflector from below. Tripod shall terminate in a vibration-proof ventilated holder gripping the top of the reflector. All metal supports shall be chemically treated to prevent corrosion and to provide a base for a high temperature baked gray enamel finish. Fixture shall be wired with No. 12 stranded Type AVA wire. Reflector shall have an overall efficiency of not less than (—)%.

#### 8.53 Fluorescent lamp reflectors.

##### 8.531 General.

Fluorescent lamps inherently provide diffuse illumination because of their size and shape and method of producing light; hence they are most suitable for spread type light distribution and for mounting heights of 12 to 30 ft above the floor. They may also be used satisfactorily at greater mounting heights, up to 50 feet, provided the width of the area where used is at least five times the mounting height, and proper facilities for servicing are provided.

The postwar II trend to better quality lighting has extended into the industrial lighting field, and has already influenced fluorescent reflector

design. Better seeing conditions are now provided in industrial areas by directing some of the light output from the luminaires upwards to light ceilings and upper side walls, which should be finished in light colors for maximum efficiency and to relieve brightness contrasts between lighted luminaires and their background. Upward components of light are provided by openings in the top of standard industrial type reflectors, or by ingenious design. Some industrial areas are actually being lighted by commercial lighting techniques, using Types SD, D and SI luminaires, or in some cases by trans-lighted ceilings. Where this type lighting equipment is desired, specifications given above for these types may be used. For the more conventional industrial types of lighting equipment, the following typical paragraphs will apply.

#### **8.532 Spread type distribution.**

Industrial fluorescent reflectors are normally made of porcelain enamel steel, baked white enamel steel, or aluminum. Typical specifications for a fluorescent lamp reflector luminaire equipped with a white porcelain enamel reflector is given below. Similar luminaires except equipped with steel reflectors having a high temperature baked white enamel finish, or with aluminum reflectors having an Alzak processed finish, may be similarly specified by suitably altering the specifications for the reflectors.

**Enamelled steel reflectors meeting the following specifications shall be used in locations indicated on the drawings and listed in the "Schedule of Lighting Equipment".**

The wiring channel shall be formed of not less than No. 20 gauge steel having a flanged top to stiffen and provide a point for attachment along its entire length of clamp-type hangers. Channel shall be completely wired and shall further be equipped with Certified multi-lamp ballasts, starters (omit starters for rapid start and slimline lamp reflectors), and lampholders. Channels shall be 48-in. or 96-in. long for individual or continuous row mounting, chemically treated to prevent corrosion and to prepare a base for the application of high temperature white baked enamel. Reflector shall be of special enameling steel stock of at least No. 20 gauge, with closed (opened) ends as indicated. Top of reflector shall be equipped with openings (if indirect component

is desired) which will provide an upward component of (25%) of the total light output of the luminaire. All porcelain enameled surfaces shall be free from such defects as tears, star marks, crazing, blisters, black specks, hair lines, chipping, pin holes, and other irregularities. The lower edge of the reflector shall be flanged or beaded to provide adequate stiffening. Reflector shall be readily removable from the wiring channel without the need of tools.

The overall efficiency of the complete unit in percent of the bare lumens shall be not less than 72%. Fixtures shall conform to RLM standard specifications.

#### **8.54 Mercury vapor lamp reflectors.**

##### **8.541 General.**

Mercury vapor light sources which have proven popular for industrial lighting are most commonly used in the 3-kw, 1000-watt and 400-watt sizes. Usual practice is to use the 3-kw lamps for high bay lighting with mounting heights of 35 feet and above, and 1000-watt and 400-watt lamps for medium and low bay areas with medium and wide spread reflectors, or for high bay areas with concentrating type reflectors. Typical specification paragraphs for each type are shown below.

##### **8.542 3-kw. Concentrating type reflectors.**

(Spacings should not exceed 0.8 times the mounting height).

Aluminum Alzak finished reflectors meeting the following specifications shall be used in locations indicated on the drawings and listed in the "Schedule of Lighting Equipment".

Wiring channel shall be of extruded aluminum having flanged top and bottom with two cast aluminum flange fittings to provide mounting by  $\frac{3}{4}$ -in. conduit. Reflector shall have closed ends and be formed from 0.040-in. sheet aluminum with Alzak finish. Reflector shall have a series of apertures along each side of the wiring channel over which shall be a ribbed 0.040-in. anodize aluminum plate permanently attached to the reflector to stiffen it and serve as a shield above the ventilating apertures. The lower edge of the reflector shall be flanged or beaded to provide further stiffening. Units shall be wired with No. 14 Type AVA single conductor wire. The efficiency in percent of bare lamp lumens shall be not less than (67%).

##### **8.543 3-kw Spread type reflectors.**

(Spacings should not exceed mounting heights, and 3-kw spread type reflectors should be installed not less than 35 feet from the floor).

White porcelain enameled steel reflector meeting the following specifications shall be used in locations where wide spread type light distribution is required for 3-kw mercury vapor lamps, as indicated on the drawings and as listed in the "Schedule of Lighting Equipment".

Two-terminal housing formed of not less than No. 20 gauge steel connected by a conduit wireway shall comprise the wiring channel. Terminal housings shall have removable covers to permit easy access to the lampholder terminals. Housings and wireways shall be chemically treated to prevent corrosion and to prepare a base for the application of high temperature baked enamel finish.

Reflectors shall have open ends with rounded corners and be formed of special porcelain enameling steel stock of at least No. 20 gauge. The lower edge of the reflector shall be flanged to provide stiffening. Reflectors shall be readily removable from the terminal housings without the need of special tools.

Units shall be wired with No. 14 Type AVA single conductor cable. The overall efficiency of the entire luminaire, in percent of bare lamp lumens, shall be not less than (79%).

Ballasts or transformers for the 3-kw mercury vapor lamps differ in size and electrical characteristics, and are too large for mounting within the reflector luminaire housing. Therefore they are usually furnished for single or multiple-lamp operation and mounted on a chord or I-beam (some structural member) of the roof structure adjacent or nearby to the luminaire.

##### **8.544 1000- and 400-watt reflectors.**

Mercury vapor lamps in the popular 1000-watt and 400-watt sizes may be used in the standard industrial incandescent reflectors covered in Section 8.52. Light distribution characteristics of standard incandescent reflectors do not vary greatly when mercury vapor light sources are substituted for the incandescent lamps, and for all practical purposes may be used with either light source. Ventilated neck husks are considered desirable when mercury lamps are used, to provide cooler operation for these



lamps, and may manufacturers provide such ventilated husks. Where exact light distribution characteristics are needed for reflectors using mercury vapor lamps, the reflector manufacturers can usually supply this information.

When color discrimination is required or where fast rotating machines are present in the area being lighted, incandescent reflectors should be used alternately with mercury vapor lamp reflectors, or in combination, mounting the mercury and incandescent reflectors side by side from the same suspension assembly, or high frequency fluorescent lighting should be used. Use of equal wattages of incandescent and mercury vapor lamps will minimize stroboscopic effect, and use of equal incandescent and mercury vapor lumens will provide good color discrimination. Also, the new fluorescent coated mercury vapor color corrected lamps provide excellent color discrimination.

Mercury lamps require a starting period of from four to seven minutes to enable the lamp to reach full brilliance. Interruption of the power supply, or a sudden drop in voltage of 15% or more, extinguishes the lamp so that a new starting period is required. This is another reason for combining incandescent lamps with a mercury vapor lighting system.

### 8.55 Reflector lamps.

There is a rapidly growing acceptance by industry of the self-contained reflector type lamps.

Used in locations where the air is burdened with smoke, dirt, or non-explosive chemical fumes, these lamps will maintain their light output to a high degree throughout their life without costly maintenance.

The R-52 reflector lamp, classified as medium spread, is an incandescent light source available in 500- and 750-watt sizes, and may be used for mounting heights of from 25 to 40 ft. Spacing should not exceed the mounting height above the work level.

A new self-contained reflector-type lamp is the 800-watt R-57. It has a concentrating light distribution, and is suitable for mounting heights above 40 ft. Spacing of the R-57 should not exceed 0.7 times the mounting height above the work level. The rated average life of these lamps is 2000 hours.

A reflector-type mercury vapor lamp has also been announced in the

400-watt size. It is available in the standard mercury vapor (clear bulb) type, and in the new fluorescent color corrected (phosphor coated) bulb type.

Reflector lamps require no separate reflectors but do require a Mogul screw shell socket and suspension or mounting arrangement. Metal reflectors for mechanical protection only of the lamps may also be considered desirable for some installations.

Where these lamps are specified exact method of suspension should be indicated on the drawings and the lamps should be specified by wattage and bulb designations as provided by the lamp manufacturers, and the entire assembly given a "Type" number and listed in the "Schedule of Lighting Equipment".

## 8.6 Hazardous Area Lighting

Areas which contain inflammable dusts, vapors, or gasses in explosive concentrations are classified as hazardous by the National Electrical Code, according to the degree of hazard involved. The NEC code requires that luminaires used in such areas be explosion-proof, in that they will protect the area from any explosion occurring within the luminaire.

For less hazardous areas, where the atmosphere contains non-inflammable ducts and vapors, so-called dust-tight and vapor-tight luminaires are required by the Code.

It is suggested that specifiers contact the manufacturers of any specific vapor-tight or explosion-proof type luminaires which they propose to specify for a detailed specification of the particular luminaires involved, since individual designs vary considerably in materials, mechanical and structural design details, and otherwise from one manufacturer to another. Use of the manufacturer's name, catalog number, and general description may also be used in this specification, to insure use of the exact equipment required.

## 8.7 Floodlighting

### 8.71 General.

Outdoor lighting of many types can be accomplished with suitable weatherproof reflector units, both of the open and enclosed types, commonly referred to as floodlights. These include the lighting of outdoor recreational facilities and areas, outdoor production areas, storage yards, the lighting

of signs, water towers, smoke stacks, monuments and buildings, and protective lighting of public utility and other properties including commercial and industrial buildings and many others. Self-contained weatherproof reflector-type lamps in suitable weatherproof metal housings may also be used for some of these simpler installations where economy and tight distribution control are major factors.

Floodlights may be classified for specification purposes under four general groups and six types of light distribution, as follows:

#### Group Description

- A—General-purpose enclosed, less than 17-in. diameter
- B—General purpose enclosed, 17-in. diameter and over
- C—Open-porcelain enameled, without auxiliary reflector
- D—Open-porcelain enameled, with auxiliary reflector

The six types, classified according to beam spreads, follows:

#### Type Beam Spread

- 1—10° to 18°
- 2—18° to 29°
- 3—29° to 46°
- 4—46° to 70°
- 5—70° to 100°
- 6—100° and up

Open aluminum reflectors with diffuse finish may also be classified as Group C, and those with specular finish as Group D.

## 8.72 Typical specifications.

Following is a typical specification paragraph, which should be altered for specific cases to suit the conditions and units required.

**Floodlights shall be of the general purpose enclosed type, (14) inches in diameter with beam spread of (30°). Reflector shall be fabricated of special aluminum sheet having a thickness after fabrication of not less than (0.036) inches. Beam efficiency shall be not less than (50%). Floodlight shall be equipped with a clear cover glass of high-stress heat resisting glass held in non-corrosive hinged type frame, gasketed to assure against water and dirt entering the reflector.**

All floodlights shall be of size and types as indicated on the drawings and as listed in the "Schedule of Lighting Equipment". Floodlight units shall further comply with and meet the standard design and photometric characteristics established by the National Electrical Manufacturers Association (NEMA).



### 8.73 Spread lens cover glasses.

Elliptical-spread cover glasses are generally available for enclosed general purpose floodlights which appreciably spread the beam in one plane only, and are of two types generally for floodlights having beam spreads up to 46°; that is, *medium spread* and *wide spread*. Typical specification paragraph follows.

**Floodlights Type (A, B) shall be equipped with *medium spread* (wide spread) cover glasses which will provide an elliptical beam 20° (up to 40°) greater than the spread of the floodlight without this cover glass.**

If the wide beam spread is desired, the following typical specification paragraph should be used:

**Floodlights Type (A, B) shall be equipped with *wide spread* cover glasses which will provide an elliptical**

**beam at least 40° greater than the spread of the floodlight beam without a cover glass.**

## 8.8 Emergency Lighting Units

### 8.81 General.

The luminaires or lighting units used with emergency lighting systems (Section 6.0) are in many cases standard incandescent luminaires, or units, connected to the wiring circuits of the emergency lighting system. In some cases (e.g., "exit" lights), they are specially designed with letters meeting the size and color requirements of local or state ordinances, laws and codes.

It is good practice to use incandescent lamps in all emergency lighting units, as they are more reliable in their operation under varying voltage

conditions, etc., than other types of light sources. Lighting unit designs may include any size or shape or decorative treatment within limits set by local or other applicable codes. Units may also be individual units, or may be combined with general lighting luminaires served by normal power supply. No standard specification is given here because of this wide range in the many designs and types of units generally available.

The specifier should prepare a specification paragraph for each type emergency lighting unit selected for a project, and should clearly state in his specification that these units are to be connected to the emergency lighting circuits. These units should also be listed in the "Schedule of Lighting Equipment", and detailed on the drawings to clearly indicate all unusual features of construction.

# 9.0 Motors, Generators and Controls

In the electrical specifications for any job—industrial, commercial or residential, detailed information on motors, generators and their related switching and control equipment should be included. All such information is logically grouped in one section of the specification because it involves a wide range of data on closely related factors. Usually, installation techniques, code considerations and equipment layout follow more or less of a pattern throughout the entire job; and the installer thinks of motor installation as a type of work. For these reasons, conditions and requirements which apply to motors and motor control are best separated from other sections of the specifications. The separate section can be entitled "Motors and Controls" or "Motors and Generators" or "Motors, Generators and Controls." Of course, exact title and layout for the section will depend upon the nature of the job and particular conditions which prevail. The number, type, sizes and locations of motors, generators and their controls will vary greatly from job to job.

Specifications for motors and generators and the related equipment used to supply and control them should cover the following considerations:

1. Who is to furnish the equipment;

who is to set or mount it; and who is to install or connect it.

2. What are the physical characteristics, sizes, ratings and performance capabilities of the equipment.

3. What are the particular installation requirements—mounting details, connecting methods, protective guards, type of coupling to machines, etc.

Actual detail of the installation of motors, generators and their controls in any electrical specification will depend upon how the first of the above considerations is resolved. In those cases where the equipment is furnished by others to be installed on the electrical system as part of the electrical contract, the specifications should cover data on the wire, conduit and other devices which are furnished as part of the contract. When equipment is furnished as part of the electrical contract, specification data should be given to clearly and completely describe the equipment. In all cases, however, the amount of detail in the specifications should be sufficient to complement the details given in the electrical plans and to make any necessary clarifications of the plans.

The following outline covers a wide range of possible data for electrical specifications on motors and generators and their controls. Some of the

suggested entries may duplicate data which is also presented in other parts of the specifications, such as "General Conditions" or "Scope of Work." However, important instructions to the contractor should be repeated where they apply, to eliminate confusion, misunderstanding and possible costly errors on the job. Paragraphs presented in boldface type are examples of typical specification clauses.

## 9.1 Furnishing of Equipment

(Either by electrical contractor or others).

### 9.11 Supply.

Who furnishes the various motors, motorized equipment, generators, various motor controllers, associated control devices, disconnect switches, conductors and raceways supplying motors and generators?

**The contractor for electric wiring shall furnish electric motors and controllers as shown on plans. All conductors and raceways necessary to operate motors and their control equipment shall also be furnished by the contractor for electric wiring. The electrical contractor shall furnish a disconnect switch for each motor as shown on plans.**

# MOTOR SELECTION CHART

Basic Motor Types	HP Ratings	Motor Operating Classifications	Application Data
Direct-current motors 115, 230 volts d.c.	Fractional to several hundred hp.	Series-wound	For high starting torque, with speed control depending upon load—cranes, hoists, elevators, electric railway cars, locomotives and trucks. In fractional hp. sizes—sewing machines, vacuum cleaners, electric fans, and hair driers (usually the universal type motor).
	Fractional to several thousand hp.	Shunt-wound	For constant-speed or adjustable-speed, with good speed regulation—drives for milling machines, centrifugal pumps, lathes, conveyors, grinders, blowers, shapers and elevators.
		Compound-wound	Offers constant-speed and variable-speed action, with a definite zero load speed and high starting torque. Used with fly wheels on punch presses, power shears, hoists, rolling mill drives and conveyors.
Universal motor 115, 230 volts d.c. or 1 phase a.c.	Fractional and several hundred hp.	Series-wound or compensated series-wound	A special adaptation of the direct-current series motor. Applications are same as for fractional hp. d.c. series type. In larger sizes, for electric railways.
Single-phase a.c. motors 110-220-440-550 volts	Fractional hp.	Shaded-pole induction motor	For small appliances and devices requiring low starting torque—small fans, motion picture projectors and similar small constant-speed devices.
	Fractional to 5 hp.	Split-phase start induction motor	For moderate starting torque and constant-speed—small machine tools, oil burner motors and small appliances.
		Reactor-start split-phase induction motor	Same as split-phase start induction motor, but requires less starting current.
	Fractional to 15 hp.	Capacitor-start split-phase induction motor	For high starting torque, constant speed and low noise—air conditioning equipment, large fans and commercial refrigeration equipment.
		Capacitor-start and run induction motor	Similar to capacitor-start split-phase induction motor, but in larger sizes, with increased power factor and smoother, quieter operation.
	Fractional to 40 hp.	Repulsion motor	For varying-speed, high starting torque and low starting current—pumps, stokers, conveyors, compressors and similar applications when polyphase current is not available.
		Compensated repulsion motor	Similar to repulsion motor, but with improved power factor and constant- or varying speed.
		Repulsion-induction motor	Similar to repulsion motor, but with constant- or varying-speed.
		Repulsion-start induction motor	Similar to repulsion motor, with high starting torque and fairly constant speed.
	½ to 400 hp.	Squirrel-cage induction motor	For high reliability and efficiency at essentially constant-speed, requiring little maintenance. Depending upon construction, classifications are as follows: normal-torque, normal starting current; normal-torque, low starting current; high-torque, low starting current; high-slip; low starting torque, normal starting current; low starting torque, low starting current. For rotary compressors, machine tools, large fans, light conveyors, milling machines, agitators, elevators, hoists, punch presses, centrifugal pumps and blowers.
3-phase a.c. motors 208-220-440-550-2200-2300-4000 volts	½ to several thousand hp.	Wound-rotor (slip-ring) induction motor	For limited speed control and speed adjustments under fluctuating load, with low starting current—conveyors, fans, lift bridges, cranes, hoists and drives for metal-rolling mills.
	20 to several thousand hp.	Synchronous	For power factor correction and for exact slow-speed drives and maximum efficiency on continuous loads above 75 hp.

## 9.2 Installation of Equipment

(Either by electrical contractor or others).

### 9.21 Connections.

Who mounts and sets the various motors and motorized equipment, the various controllers and disconnect switches, the various motors and controllers to their electrical supply circuits, and who couples motors to their driven machines?

The contractor for electric wiring shall install motor feeders and branch circuits, motor controllers and starting devices, motors and generators, and protective devices, except where specifically stated as part of other contract.

## 9.3 Dc and Induction Motors

### 9.31 Dc motor characteristics.

Manufacturer's type and frame designation, horsepower output, time rating, temperature rise, rpm at full load, voltage, full-load amperes and winding—shut, compound or series.

### 9.32 Polyphase squirrel-cage.

(Also to describe ac single-phase motors.)

Manufacturer's type and frame designation, horsepower output, time rating, temperature rise, rpm at full load, frequency, number of phases, voltage, full-load amperes and "code" designation of locked-rotor kva per horsepower.

NEMA design letters for integral-horsepower motors — locked-rotor and breakdown torques; locked-rotor current; and percent slip at rated load.

### 9.33 Polyphase wound-rotor.

Cover items given above for polyphase squirrel-cage motors, plus secondary amperes at full load and secondary voltage.

### 9.34 Small units.

Motors rated less than 1/20 hp—complete motors sold separately as motors. Indicate type designation, power output (millihorsepower—mhp) full-load speed, voltage rating, frequency, number of phases and type of overheating protective device.

### 9.35 Universal motors.

Manufacturer's type and frame designation, horsepower output, time rating, rpm at full load, voltage, full-load amperes and frequency (60/dc is recommended form).

### 9.36 Application.

General-purpose motor; definite-purpose motor; or special-purpose motor.

### 9.37 Mechanical protection.

Also describe method of enclosing: drip-proof; splash-proof; semi-protected; protected; drip-proof fully protected; open externally-ventilated; open pipe-ventilated; totally-enclosed non-ventilated; totally-enclosed fan-cooled; explosion-proof; dust-explosion-proof; water-proof; totally-enclosed pipe-ventilated.

### 9.38 Variability of speed.

Constant-speed; varying-speed; adjustable speed; adjustable varying-speed; multispeed.

### 9.39 Miscellaneous data.

Efficiency; power factor; service factor; various torques—full-load, locked-rotor, pull-up, breakdown, pull-out, pull-in.

Motors for operating (elevators, conveyors) shall be of the polyphase squirrel-cage induction type rated for ... hp, ... volts, ... phase, ... cycles, ... rpm, NEMA design ... (A, B, C, D, E, F), with Class ... insulation and ... bearings. Enclosure shall be ..... (open drip-proof, splash-proof, fan-cooled totally-enclosed), for ... degree C continuous temperature rise, with ..... (normal or quiet) operation. Frame number shall be ..... with the following dimensions: .....

## 9.4 Synchronous Motors

### 9.41 Separately excited.

Revolving field (rotor) or stationary field (stator).

Manufacturer's type designation and frame number. Horsepower output, time rating, temperature rise, rpm at full load, frequency, number of phases, voltage, rated amperes per terminal, rated field current, rated exciter voltage, rated power factor and torques (percent of rated full-load torque)—locked rotor, pull-in and pull-out.

Motors for operating (fans, pumps, blowers, compressors and other constant-speed loads) shall be of the synchronous ..... (engine, coupled, belted) type arranged for ..... (horizontal, vertical) operation and rated at ... hp, ... volts, ... phase, ... cycles, ... power factor, with a starting torque of ... % full-load

torque, a pull-in torque of ... % full-load torque. Motor and its control shall limit kva inrush at starting to ... % full-load kva. Excitation for the motor field shall be provided from a ..... motor-generator set, a belted exciter, a direct-connected exciter, or a dc bus. Maximum temperature rise for the stator shall be ... degrees C; for the field, ... degrees C. Maximum excitation required shall be ... kw at ... volts. Efficiencies at ... % power factor shall be: ... for full load, ... for ¾ full load, ... for ½ full load.

## 9.5 Generator Characteristics

### 9.51 DC general purpose.

(Up to 150 kw).

Manufacturer's type designation and frame number, kilowatt output, time rating, temperature rise for rated continuous load, rated speed in rpm, voltage, rated current in amperes, winding—series, shunt or compound, excitation voltage, or self-excited and recommended value of resistance for rheostat for hand or regular control of output.

### 9.52 Large dc units.

Larger than general purpose (over 150 kw).

Manufacturer's type designation and frame number, kilowatt output, time rating, temperature rise for rated continuous load, overload, time rating of overload, temperature rise for overload, rated speed in rpm, voltage rating, rated current in amperes and winding—series, shunt or compound field winding.

### 9.53 Synchronous.

Manufacturer's type designation and frame number, kilovolt-ampere output, power factor, time rating, temperature rise for rated continuous load, rated speed in rpm, voltage, rated current in amperes per terminal, overload, time rating for overload, temperature rise for overload, number of phases, frequency, rated exciter voltage and rated field current.

### 9.54 Motor-generator sets.

Induction or synchronous direct-current).

Motor voltage, horsepower, number of phases and frequency, kilowatt and speed rating, frame type, power factor and generator voltage.

Emergency electric generator shall be a fixed, diesel-powered ac unit, ... phase, ... cycles, ... volts, ... wire



## SELECTION DATA FOR 3-PHASE 220-VOLT MOTORS

Motor Rating HP	Full-Load Current Amps	Running Protection Amps	Starting Fuse — Amps			Branch CB — Amps			R-Wire		T-Wire		RH-Wire	
			Standard Squirrel Cage Motors	High Reactance Motors	Wound Rotor Motors	Standard Squirrel Cage Motors	High Reactance Motors	Wound Rotor Motors	Wire Size	Conduit Size	Wire Size	Conduit Size	Wire Size	Conduit Size
1½	5	8	15	15	15	15	15	15	14	½	14	½	14	½
2	6.5	8	20	15	15	15	15	15	14	½	14	½	14	½
3	9	12	30	25	15	20	20	15	14	½	14	½	14	½
5	15	20	45	40	25	35	35	25	12	½	12	½	12	½
7½	22	30	70	60	35	50	50	35	10	¾	10	¾	10	¾
10	27	35	90	70	45	50	50	50	8	¾	8	¾	8	¾
15	40	50	125	80	60	70	70	70	6	1	6	1	6	1
20	52	70	175	110	80	90	90	90	4	1¼	4	1¼	6	1
25	64	80	200	150	100	100	100	100	3	1¼	3	1¼	4	1¼
30	78	100	250	175	125	125	125	125	1	1½	1	1½	3	1¼
40	104	150	350	225	175	175	175	175	2/0	2	2/0	2	1	1½
50	125	175	400	250	200	200	200	200	3/0	2	3/0	2	2/0	2
75	185	250	600	400	300	300	300	300	300 MCM	2½	300 MCM	2½	4/0	2½
100	246	300	—	500	400	—	400	400	500 MCM	3	500 MCM	3	350 MCM	3
150	360	450	—	—	600	—	—	550	1000 MCM	4	1000 MCM	4	700 MCM	3½

output, ... kw, ... power factor. All essential control equipment shall be supplied and unit shall be adapted for ready connection to electric power lines. Drive shall be diesel powered with No. ... fuel oil with minimum of ... degree Baume test and octane rating of .... Drive shall be ... hp, at ... rpm, equipped with governor and starting devices.

Motor-generator equipment shall be suitable for operation from a 230-volt dc power circuit in conjunction with a 440-volt, 3-phase, 60-cycle power circuit to deliver 10 kw at 80% power factor, 120/208 volts, 3-phase 4-wire power at any frequency adjustable over the range 400 to 850 cycles per second. Unit shall be open horizontal ball bearing motor-generator set to consist of the following units direct connected and assembled on a common steel base: type CD, frame 85, 20 hp, constant hp, 1710-3640 rpm, adjustable speed, 230-volt shunt-wound direct-current motor with 160-volt field for excitation from the amplidyne of item 3c; and a type ATC, frame 504, 28-pole, 12½ kva, 10 kw, constant kw, 80% power factor, 1710-

3640 rpm, 120/208 volt, constant voltage, 3-phase 4-wire, 400-850 cps, adjustable frequency ac generator, with wave form deviation factor not to exceed 5% line to line nor 10% line to neutral, with voltage regulation not to exceed 40% at 850 cps, with an 80-volt field for excitation from the amplidyne generator of item 3b. ...

### 9.6 Motor Controls

Where several motors of like capacities, design, characteristics and purposes are installed, it is convenient to include detailed specifications concerning control in with the specifications of the motors themselves. However, when numerous motors of widely varying capacities, characteristics and functions are to be installed, a general specification can be written to cover all motor control equipment, with additional clauses covering those installations which do not follow the pattern.

Such general specifications could follow the outline presented below. Concerning these general clauses, it

should be mentioned that only the more common types of general-purpose motor control devices for alternating current motors are referred to. To specify controlling equipment for special applications, it is well to consult the manufacturers.

#### 9.61 Direct-current.

Consider all of the following items:

Type: across-the-line, start-stop (and reverse), standard or heavy duty automatic reduced voltage.

Horsepower rating and type of motor controlled.

Voltage of line to which control is connected, and full-load motor current.

Type of enclosure: NEMA Type I, Standard; Type II, Drip-tight; Type III, Weather-resistant; Type IV, Water-tight; etc.

Overload protection, reset button.

Pilot device; pushbutton station; float switch, thermostat; etc.

Automatic operation; accelerate shunt, series and compound motors; accelerate shunt and compound motors; not suitable for jogging; etc.

Time limit of automatic operation:



designed for one 10 second start out of each 80 seconds.

For constant speed or adjustable speed motor, number of accelerating points.

Non-reversing, with or without braking; reversing, with braking.

Field accelerating and decelerating relays.

Low voltage protection.

Field rheostat: manual, enclosed, for particular motor speed range of particular size motor.

Other relays: control, field protective, field failure.

### 9.62 Alternating-current.

Consider all of the following items:

Type: across-the-line, manual starting switch; across-the-line, magnetic switch; reduced voltage starter.

Horsepower rating and type of motor controlled.

Line voltage, frequency, full-load motor current and number of phases.

Type of enclosure: NEMA Type I, Standard; Type II, Drip-tight; etc.

Overload protection.

Pilot devices: pushbutton station; control switch; relay; thermostat; etc.

Number of poles.

Reversing.

Combining a disconnect switch or circuit breaker in the same enclosure, with or without fuse clips for fuses of particular size.

No voltage protection.

Maximum primary running current, for primary control of slip-ring motor.

For constant-speed or adjustable-speed motor operation.

Relays: automatic reset; low speed start; accelerating; decelerating; etc.

For multispeed operation: consequent pole or separate winding; constant torque, variable torque or constant horsepower.

Reduced voltage starters: manual resistance type; manual autotransformer type; magnetic resistance type; three-point resistance type; magnetic stepless resistance type; magnetic transformer type.

For reduced voltage operation: particular conditions of the starter application—characteristics of driven machine, hookup of pilot devices, frequency of starting.

Synchronous motor starters: semi-magnetic, reduced voltage, autotransformer type; magnetic, full voltage, across-the-line type; reduced voltage, resistance type; reduced voltage, autotransformer type.

For synchronous motor starters:

kva, rpm, power factor, full load amperes, phases and frequency, voltage, field voltage, excitation amperes, size and rating of field discharge resistor.

Squirrel-cage motor starters for high voltage: across-the-line type; reduced voltage, autotransformer type.

For high voltage squirrel-cage motor starters: locked rotor current of motor.

Reversing drum switches for starting and reversing squirrel-cage motors, for ac or dc, with spring or non-spring return, for surface, panel or switch-board mounting.

Multispeed drum switches for manually starting, speed changing and reversing three- and two-phase multispeed motors, reversing or non-reversing.

Non-reversing drum switches for polyphase wound-rotor induction motors, for starting and speed regulating—with grid resistors and characteristics matched to operating conditions of the controlled motor.

### 9.63 Motor control devices.

Consider all of the following: manual speed regulators. Push-buttons: standard duty, heavy duty, oiltight stations, etc. Limit switches: ac, dc, precision. Plugging switches. Overload relays: thermal, magnetic. Switches: pressure, temperature, float. Timing relays: pneumatic, fluid dashpot, motor-driven, electronic, etc.

Following the above checklist, a specification might include the following typical clauses.

**Controls for (fan, pump, etc.) motor shall provide for (full, reduced voltage) starting of the ... hp, ... rpm, ...% P. F., ... volts, ... phase, ... cycle motors and shall be provided with NEMA I enclosures, and designed for (full magnetic, semi-magnetic) operation. Reduced voltage at starting shall be obtained by means of (autotransformer, reactor, resistor) and shall limit the kva inrush to a maximum of ...% of full load kva.**

**The control shall provide for overload, undervoltage, damper winding and pull-out protection and, after pull out of step, will automatically stop (or resynchronize) the motor. Control shall be manufactured by ....., type ....., or approved equal.**

**Controls for squirrel-cage motors shall be enclosed combination 3-pole across-the-line starters with circuit breakers in NEMA type ... en-**

**losures with self-indicating handles and shall provide overload, low voltage and short circuit protection. Breakers shall trip at ... amps. Remote 2-unit standard duty pushbutton stations, momentary-contact, marked "Start-Stop," shall be provided in NEMA type ... enclosures. Starters shall be manufactured by ..., Class ..., Type ..., or approved equal.**

Each motor rated at 1/6 hp or over shall be equipped with a starter or controller which will provide running overcurrent protection for the motor. Overcurrent devices shall open all leads to the motor except that for 2-phase motors, only three leads are required to be opened. All starters and controllers shall be enclosed in substantial metal enclosures and shall conform with the NEMA Industrial Control Standards.

Type A starters shall be manually operable by means of a lever, knob or pushbutton, for full-voltage starting.

Type B starters shall be magnetically operable, for full voltage starting, and shall be provided with undervoltage protection. Provision shall be made for remote control by means of wires leading to other control stations.

Type C starters shall be of the manually operable autotransformer type, for reduced voltage starting. Each starter shall be provided with undervoltage protection and shall have a stop pushbutton in the cover.

Type D starters shall be of the magnetically operable autotransformer type for reduced voltage starting. Each starter shall be provided with undervoltage protection and shall be arranged for remote control.

Type E starters are for use with wound-rotor motors for starting duty only. Each controller shall consist of an assembly of a magnetically-operated primary switch and a resistor switch with suitable resistors. The primary switch shall provide running overcurrent protection and undervoltage protection for the motor. The resistor switch shall be electrically interlocked with the primary switch so that the primary switch cannot be closed unless all resistors are connected. Resistor switches shall be of the dial type for motors of 10 hp rating or less and shall be of the drum type for larger motors.

Type F controllers are for use with wound-rotor motors for speed regulation duty and shall provide for 50%

speed reduction and continuous operation at any speed from maximum to minimum. Type F controllers shall in all other respects conform with the specifications for Type E starters.

All control equipment shall be mounted with operating levers or push-buttons at a height of approximately four feet above the floor. All necessary expansion bolts, brackets and other structural steel parts shall be furnished to provide secure mounting on walls, columns or machine frames as indicated on the plans or, where so indicated, equipment shall be mounted on frames.

## 9.7 Installation Details

### 9.71 Special drawings.

To be submitted on how certain installation details are accomplished on the job.

### 9.72 Wiring instructions.

Covering the scope of the electrical contractor's work in hooking up motors and their controllers.

### 9.73 Outlet locations.

For motor controllers—position, height, mounting for specific areas.

### 9.74 Type of feeders.

Conduit; busway.

### 9.75 Motor installation.

As shown on plans or with changes.

Feeder conduit directly into terminal box on motor. Flexible metallic cable from end of feeder conduit to motor terminal box. Method to be used with sliding-base motors. Details on specific machines, motors or terminals.

### 9.76 Controller installation.

Locations of controllers. Grouping in control centers. Hookup of control relays and auxiliary devices. Barriers, supports and enclosures for mounting the controls. Arrangements of controller groups.

### 9.77 Disconnect switches.

Separate or in combination with motor starter.

Branch circuit breaker as disconnect when controller location is within sight of the distribution panel. For single motor on a branch circuit, on-fuse disconnect switch. Separate disconnect for each motor on a single branch circuit.

### 9.78 Method of coupling.

Motor to driven machine—sheaves and belts. Type, construction and installation of sheave guards.

Covering all of the above items, a specification might include the following typical clauses.

Motors shall be located as indicated on the drawings, positioned so as to permit unhindered maintenance, bearing lubrication and brush replacement. Totally-enclosed motor housings shall be used where conditions of excessive moisture, steam, dripping oil, dust, acid fumes or explosive conditions exist.

Starting devices, controllers, relays, thermostats and photocell switches shall be connected to all motors in (rigid or flexible conduit, armored cable or EMT). Where motors have conduit terminal boxes, feeder conduit shall be connected directly into same. Fans and pumps and all motors having sliding bases shall have not less than 18 in. nor more than 6 ft of armored flexible conduit from end of rigid conduit to motor terminal box. Under no circumstance shall rigid conduit terminate in or be fastened to motor foundation. Power supply leads to motors from controllers shall conform to drawings and recommendations.

Stationary motors shall have grounded frames when the motors operate at over 150 volts to ground when (1) they are located in unguarded, moist locations, (2) when they are connected to metal-enclosed branch

wiring circuits, and (3) when they are located in hazardous locations. Grounding shall be accomplished by connecting the branch cable armor to the motor frame.

Portable motors *shall* be grounded in like manner when these units operate at over 150 volts to ground, and *should* be grounded whenever readily accomplished. Motor frames shall be grounded by use of a jumper attached to the frame and connected to the conduit supplying the feed of the motors.

Grounding of disconnect switches, starters, controllers, cabinets and the like shall be accomplished by the use of double lock-nuts and bushings attached to clean bare metal surfaces void of any paint.

All fans and other motorized equipment as shown in the feeder diagrams and schedules shall be provided with auxiliary relays at starter locations, with control wiring connections made into starters and to a master pilot light and control panel in engineer's office. There shall be a pilot light for each fan motor. For the cooling tower fans on the roof, start-stop remote control pushbuttons shall be provided under the pilot light for each tower fan. For all other fan motors, a stop pushbutton station shall be provided and mounted under their respective pilot lights.

Relays, pilot lights and remote control pushbutton stations shall be of such type and so wired that a pilot light operates when motor operates, and pushbuttons permit remote stopping of motors individually, or start-stop control of cooling tower fan motors.

Disconnecting means: Where required by the National Electrical Code, a manually operable disconnecting means shall be provided for each motor or for each group of motors driving the several parts of a single machine.

# 10.0 Heating and Air Conditioning

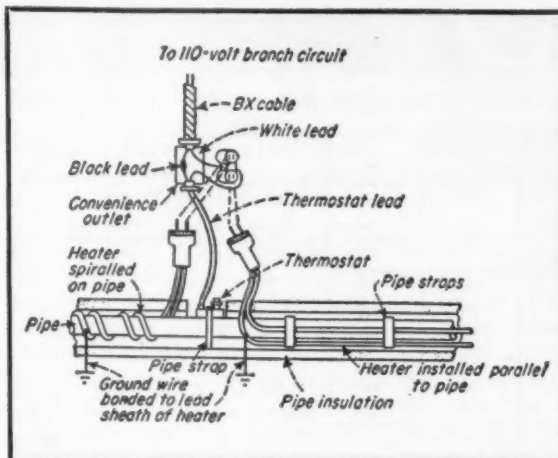
Ventilation and air-conditioning equipment is available in a wide selection of packaged, easily-installed forms. Choice of equipment is extensive, ranging from air movement only to the fields of controlled humidity, temperature, motion and the removal of dust, gases or bacteria from the atmosphere. Air movement only satis-

fies the requisites of ventilation, with fans and exhaust units available for supplying or removing air to or from enclosed space by either natural or mechanical means. Complete air conditioning units are of course more comprehensive in their equipment and control.

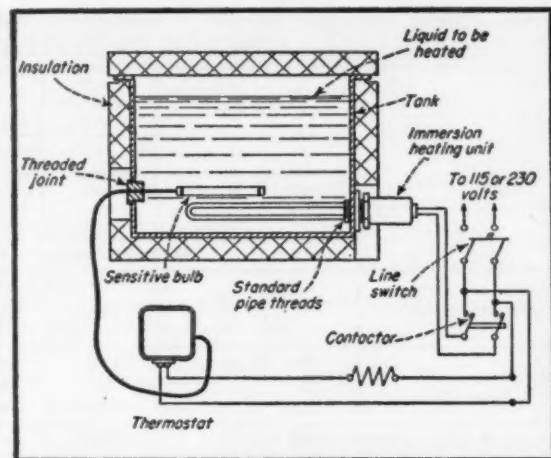
In most instances, the installation of

unit air-control apparatus combines the mechanical problems of locating and attaching the equipment with the electrical problems of wiring and control. Substantially, this covers the same scope and involves much the same techniques used to install most types of electrical equipment.

Where close control and exact ca-



Heating cable can be installed parallel to, or wound spirally around, pipe lines. Heat is confined by pipe insulation and controlled by means of a thermostat clamped directly to the pipe being heated.



Immersion unit is controlled by magnetic switch and thermostat. Unit is sweated into threaded collar that screws into standard pipe threads.

capacities are not critical, savings can be achieved by specifying factory-assembled units combining air handling with condensing equipment in a single cabinet, balancing the capacities of coil and condenser. These combination units widen the compromise between actual load and rated capacities of the conditioners, but units of  $\frac{1}{2}$ ,  $1\frac{1}{2}$ , 3, 5,  $7\frac{1}{2}$ , 10 and 15 ton refrigeration capacity are proving economical in many locations.

Vibration dampeners of either felt, sponge or rubber-in-shear should be used to isolate and minimize the transmission of sound or motor motion. Floor and beam loadings should be checked before installing conditioners, for suspended units can add up to 100 lbs/sq ft, and self-contained units can double that figure.

Wiring should be sufficiently heavy to minimize voltage drop, for voltage drop has a definite effect on equipment life through slower starting. A separate circuit is not only desirable, but definitely necessary in most instances, for combined light-and-power circuits will adversely effect the lighting potential. Air-conditioning circuits should be 12-gauge or larger, with flexible conduit used for motor connections to prevent sound and vibration transmission. To avoid confusion with light switches, control switches for air control equipment (either single or 3-way) should be located at least a foot above the customary height of the light switches.

The use of electric heat is constantly growing; applications and advantages are countless. Controls and

protective devices are reliable, units are relatively compact and light in weight, installation and maintenance are simple, heat losses are restricted and gases associated with conventional forms of open-flame heat are absent.

Unit heaters, infrared lamps, all-metal radiant units, encased elements, heating cable and induction heating can be specified to advantage. It must be recalled, however, that the efficiency of any of these methods depends upon two primary factors: selec-

tion and application. The former is governed by the desired heat range, available space, characteristics of the material being heated and the designed purpose of the heating element being considered. The latter factor—application—will depend upon the proximity of the heater to the objective, the efficiency of surrounding insulation and heat lost through radiation, convection or conduction.

Electric self-contained space-heating units operate with either exposed or enclosed heating elements. Reflec-

UNIT SIZE HP	VOLTAGE RATINGS AVAILABLE									
	60 Cycle					50 Cycle				
	1-Phase	2-Phase	3-Phase	1-Phase	3-Phase	1-Phase	2-Phase	3-Phase	1-Phase	3-Phase
	115 208 230	220 440	208 220 440 550	100 200 230	208 220 380 440	115 208 230	220 440	208 220 440 550	100 200 230	208 220 380 440
$\frac{1}{3}$	X			X						
$\frac{1}{2}$	X X X			X X						
$\frac{3}{4}$	X X X			X X						
1	X X			X X						
$1\frac{1}{2}$	X X									
2		X X X	X X X X							X X
3		X X X	X X X X						X X X X	
5		X X	X X X X						X X X X	
$7\frac{1}{2}$	X		X X X X						X X X X	

**CROSS-REFERENCE DATA** on electrical specifications of unit-type conditioners shows available voltage, phase and frequency ratings for various sizes.



# SCHEDULE OF TYPES OF ELECTRIC HEATING

HEATER TYPES	NATURAL CONVECTION HEATERS		FORCED CONVECTION HEATERS	RADIANT HEATERS				DUCT HEATERS	
	Resistance Element in Air	Resistance Element in Steam or Hot Water Radiator	Resistance Element in Air	Resistance Element in Air	Glass	Asbestos or Ceramic	Conductive Rubber		Space Heating Cable
	RATINGS AVAILABLE (Watts)								
A. Ceiling Panels or Units	...	...	1000	250 to 750	450 to 2500	...	For mounting on ceilings and walls  Panel sizes available:  3'x4' 4'x4' 4'x6'  at 17 and 22 watts per sq ft	For embedding in ceilings or floors  Available in almost any length  Wattages vary with length	For installation in heating and air conditioning ducts  Available from 5 to 300 kilowatts
B. Wall Panels or Units, Surface or Recessed	250 to 8000	...	1200 to 5000	1000 to 3000	450 to 1500	750 to 1250			
C. Bracket or Pedestal Units, Commercial or Industrial	250 to 8000	...	15,000 to 60,000	...	...	...			
D. Baseboard Panels or Units	420 to 1400	...	...	...	750 to 3000	2880			
E. Floor Units, Recessed	3000 to 8000	...	...	...	...	...			
F. Standing Units, Fixed	703 to 2800	1500 to 3000	20,000 to 40,000	...	...	...			
G. Portable Units or Panels, Residential	1000 to 8000	1000 to 1500	800 to 5000	1000 to 1650	1000	1000			
H. Portable Units, Commercial or Industrial	1000 to 3000	...	1320 to 7500	...	...	...			
J. Explosion-Proof Units	1000 to 6000	2000 to 3000	...	...	...	...			

tors, deflectors, diffusers and forced-air fans may also be incorporated in the units, and a wide variety of mounting brackets, hangers and pedestals provide versatility for numerous installation methods.

Because of the vital function performed by unit heater motors, careful consideration should be devoted to wiring, control and accessory electric equipment. Such equipment includes: (1) fused disconnect switches for isolating wiring systems or sections thereof from the power source, providing instantaneous protection in cases of short circuiting or grounding; (2) starters, with or without integral overload protection, for connecting motors to power source; (3) magnetic relays for connecting a number of motors to power circuit, with a single set of automatic control instruments controlling several heating units; (4) selector switches for operating motors without resetting thermostats or limit

controls; (5) thermostats to start motors when space temperatures drop below predetermined settings, and (6) limit controls for measuring temperatures or pressures of heating mediums, insuring that motors operate only when elements have reached their functional level, and that cold air will not be discharged.

## 10.1 Electric Heating

### 10.11 Type of units.

### 10.12 Natural convection.

Wall panels; baseboards; floor furnaces; electric steam radiators; hazardous location; portable.

### 10.13 Forced convection.

Wall panels; suspended; portable.

### 10.14 Radiant.

Glass panels; ceramic panels; asbestos panels; rubber panels; heating cable; resistance units; lamp heaters.

### 10.15 Duct.

Resistance; blast coil.

### 10.16 Voltage.

Also phases, frequency.

### 10.17 Kw power rating.

Also Btu/hr capacity.

### 10.18 Control.

Ratings.

### 10.19 Installation instructions.

Mounting, fastening, connecting to supply circuits, hookup of controls, special guards or enclosures.

Typical specification data, including all of these items, are as follows:

Furnish and install at the points indicated on the drawings unit heaters having minimum Btu per hour capacities, air deliveries, discharges, velocities, maximum final air temperatures and motor rpm as specified in the accompanying schedule.

Unit heaters shall be of the pro-



peller fan type, having — watts capacities, as manufactured by —, so designed as to permit direct suspension. They shall be controlled (manually, thermostatically).

Electric motors shall be totally enclosed, with speeds not exceeding 1200 rpm. They shall be resiliently mounted to the unit to insure quiet operation, and adequate means shall be provided to prevent overheating under all operating conditions, including those periods when heating elements are coming up to operating temperatures prior to the operation of fans.

Unit heaters shall be provided with fan guards capable of supporting the weight of a man accidentally leaning against same.

Propeller fans shall be designed for quiet operation, and shall be located in the streamlined air inlet to give most efficient operation. Adjustable, directional vanes shall be located on the discharge side.

Btu and cfm ratings shall be based on the standard code of the American Society of Heating and Ventilating Engineers.

Furnish and install the radiant heating system shown on the plans, completely wired and in operating condition. The panels of the ratings shown shall be installed on the ceiling and fastened as shown.

From junction boxes in the branch circuit extend (armored cable, flexible conduit and wire) to the outlet box on the back of the heat panel or to special molding as directed. Load considerations shall be the same as for lighting circuits and no diversity factor shall be applied.

## 10.2 Ventilating

### 10.21 Type.

Description of fans and blowers.

### 10.22 Voltage.

Also phases, frequency; ac or dc.

### 10.23 Diameters in inches.

### 10.24 Rpm.

Also air handling capacity in cubic feet per minute (cfm).

### 10.25 Motor hp.

### 10.26 Noise rating.

### 10.27 Controls.

Constant- or 2-speed; type and ratings.

## 10.28 Installation instructions.

Mounting, fastening, connecting to supply circuits, hookup of controls, special guards and enclosures.

A typical clause follows.

Furnish and install where shown on plans the following built-in propeller fans.

In the opening provided by others furnish and install a propeller fan to have a capacity of—cubic feet of air per minute, at a speed not exceeding —rpm, and with a decibel rating not to exceed—. The fan wheel shall be dynamically balanced and mounted directly on the motor shaft. The motor shall be dynamically balanced and provided with high quality bearings. The complete fan, including the motor, is to be guaranteed as a unit by the manufacturer who is to assume undivided responsibility.

On the exterior furnish and install a shutter (motor operated, manually operated, automatic) of the following size and type —.

Fan shall be provided with a screen guard of the appropriate size and type. Control shall be provided by means of a switch installed where shown and of the following type and characteristics (state size, catalog number, rating, number of speeds, surface or flush).

## 10.3 Air Conditioning

### 10.31 Type of units.

Window, console, self-contained commercial units, central units.

Required performance of equipment: cooling plus ventilation, circulation.

## 10.32 Size.

Tons of refrigeration capacity, Btu/hour heat removal.

## 10.33 Voltage.

Also phases, frequency; ac or dc.

## 10.34 Sizes.

Compressor motor, fan motors-hp ratings, full-load current.

## 10.35 Type of refrigerant.

## 10.36 Air handling capacities.

Cubic feet per minute.

## 10.37 Filters.

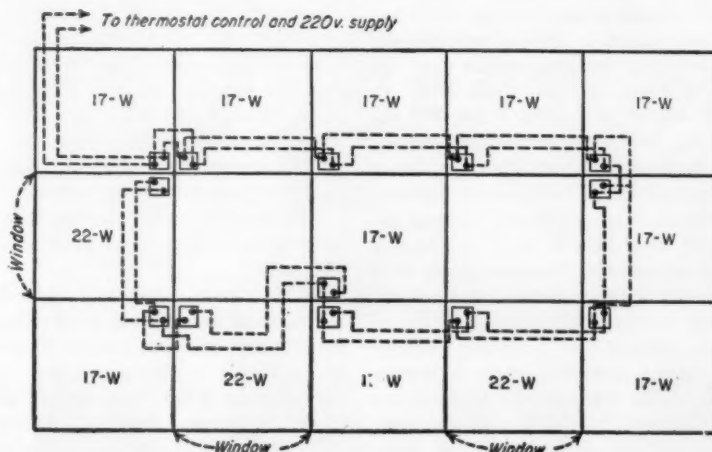
Type and description.

## 10.38 Condenser cooling.

## 10.39 Installation instructions.

Mounting, connecting to power supply circuits, hookup of controls, assembly of accessory devices in conjunction with the unit, provision for water piping and running of distribution ducts for the conditioned air.

Unit air conditioners shall be installed as shown on the plans. Room units shall be rated at — volts, — phases, (ac or dc) — cycles per second. Unit shall be rated at — Btu/hour. Compressor shall be — hp. Unit shall have full load operating current of — amperes. Air circulation capacity shall be — cubic feet per minute. Refrigerant shall be —. The condenser used in the refrigeration cycle shall be cooled by —. Distribution ducts for cooled air shall be installed as shown; a separate duct for discharge of condenser heat to outdoors shall be coupled to the unit's housing and carried through the wall as shown on the plans.



Radiant heating panels can be installed in any desired pattern to give proper warmth to any room. In this ceiling plan, units over window areas have higher capacities than the other panels. Installation is operated at 220 volts and thermostatically controlled.

# 11.0 Residential Wiring Specifications

The following design considerations and specifications are those particularly applicable to the wiring of residences and multiple occupancy dwellings in which provisions must be made for modern household appliances.

House wiring in design and function is unique among the construction features and services in the home. Other features like roofing or heating are permanent and fully integrated. Their uses will not change significantly during the life of the house even though their parts may be repaired, altered or replaced. Wiring, however, must serve not only the apparent loads at the time of construction, but many more loads which will appear as the occupants acquire appliances. Some of these loads are predictable, some are unknown.

The home buyer invariably expects that the wiring system of a new home will accept and operate efficiently any or all of the electrical appliances currently advertised that he can afford.

The Code permits a minimum of No. 6 conductors for the service entrance to a single family dwelling. Most practical installation in even the smallest home will require larger conductors.

Planning the service entrance to a new home is one of the most important aspects of wiring system design. It is a major segment of the system cost and contains a substantial percentage of the copper requirements. The service capacity must be projected well beyond immediate requirements, or the owner is saddled with an expensive and wasteful replacement job as he purchases new appliances.

Contrary to popular belief, the design of residential services and feeders is more complicated than for many larger projects. Individual residential loads are highly variable in total demand from hour to hour, day to day and by seasons. Demand grows with the individual purchase of new appliances, or better illumination.

A method of computing service entrance capacity is given in Article 220 of the National Electrical Code. It, however, is based on safety and may not be entirely adequate from an actual performance standpoint.

The Code method follows:

1. Square feet of floor area times

3 watts per-square-foot gives the design lighting load.

2. Add 1500 watts of miscellaneous appliance load.

3. Take 3,000 watts at 100%.

4. Add 35% of the remainder.

5. This is the design lighting and small appliance load.

6. For an electric range (not over 12-kw rating) add 8,000 watts.

7. Add all fixed appliances.

8. Take 75% of the total fixed appliances, if there are four or more, and add to the range, lighting and small appliance totals.

9. Divide the total by the line voltage to obtain the minimum ampere capacity for the service conductors.

As a general consideration, a well designed wiring system should operate without interruption on any probable combination of loads. Overcurrent protection should not operate to limit the reasonable use of approved equipment in satisfactory working condition. On accidental overloads, or on equipment or cord failures, the resulting interruption should be limited in extent. For instance, failure of an iron cord should not shut down the food freezer or stop the washing machine.

Adequate branch circuit capacity is one of the least expensive conveniences which can be designed into the wiring system. In practical systems it requires only a few additional panel circuits or an additional load center panel plus a few feet of additional home runs. With proper layout little more cable or wire is required. For example, a strategically located panel may serve several full circuit outlets with no more cable than would be required to loop one circuit between them. The resulting benefit of adequate branch circuit capacity is to double or triple the effective trouble-free utility of the wiring system.

The following are practical circuit modifications which increase efficiency and utility:

1. **Multiwire appliance circuits:** Kitchen and dining areas need at least two 20-amp appliance circuits to handle probable appliance groups. (A typical group which must operate efficiently at the same time is the toaster, grille and coffee maker. The connected load of these three devices may exceed 3-kw. Any two is nearly a full load for a single appliance circuit.)

A three wire common neutral circuit with each plug receptacle on alternate sides of the circuit gives some assurance against overloading.

2. **Full circuits to fixed appliances:** Modern automatic appliances in portions of their cycles often require currents near the full capacity of an appliance circuit. It is good practice to isolate such appliances on individual circuits. Typical appliances which should have full circuits are:

Dishwasher—disposal unit

Automatic washer

Room air conditioner

Ironer

Bathroom or nursery heater

3. **Full circuit to appliance groups:** Some types of automatic appliances do not offer individual loads near circuit capacity, but should be isolated as a group to assure uninterrupted operation. These include the refrigerator, food freezer and heating plant. (Some local codes require an individual circuit to an automatic heating plant.) The purpose of the separate circuit here is to avoid interruption as a result of overload or cord failures.

4. **Load center panel:** Economical circuiting for modern appliance loads usually requires the use of load center panels.

5. **Circuit protection:** Many motor operated appliances take a momentary starting current which may exceed the rated circuit capacity. Under normal conditions these overloads are harmless and should not operate the overcurrent protection device. Circuits serving appliance circuits should be equipped with circuit breakers or time delay fuses.

Single-phase motors used in electrical appliances operate at relatively low power factor. In normal operation they may require currents considerably higher than would be indicated by dividing the rated watts by the voltage.

## 11.1 Service

Furnish and install the following service entrance where shown on the plans.

Service entrance conductors shall be 3 No. — with type — insulation (R, RW, T, RH, etc.) with a total capacity of — amps.

More Specifications on Page 220



ten million jerks

a year...

can't  
shake  
these  
connections  
loose

The problem was simple—but the solution was ingenious.

To dry and sift clay in a single operation, a major Southern brick manufacturing company conceived the idea of passing current through the sifting screen itself—making it a giant resistance-heated sieve.

The electrical problem was connections that could withstand the 70 jerks each minute between the vibrating screen and the fixed bus bar.

**Solution:** Sturdy VVA clamp connectors providing tight, reliable, re-usable connections carrying 2,500 amperes at 45 volts between bus bar and strap. Their service record on this job: 5 years without a single failure!

Better electrical connections can help speed your production, improve quality, cut costs. Call on Burndy—Norwalk, Connect., Toronto, Canada. **Factories:** New York, Calif., Toronto. **Export:** Philips Export Company.

**BURNDY VVA: V-BOLT TYPE, ENGINEERED TO HOLD TIGHT UNDER CONTINUOUS VIBRATION. RE-USABLE.**

*It's good business to connect with...*

# BURNDY

54-23

...**FIRST** name in electrical connectors; tools; methods

# 12.0 Data Tables

## NUMBER OF CONDUCTORS IN CONDUIT OR TUBING

Rubber Covered, Types RF-32, RUF, R, RH, RW, RU, and RUW  
Thermoplastic, Types TF, T and TW  
One to Nine Conductors

Size AWG MCM	Number of Conductors in one Conduit or Tubing								
	1	2	3	4	5	6	7	8	9
18									
16									
14							1	1	1
12						1	1	1	1
10					1	1	1	1	1
8				1	1	1	1	1	1
6		1	1	1	1	1	2	2	2
4		1	1	1	1	2	2	2	2
3		1	1	1	2	2	2	2	2
2		1	1	2	2	2	2	2	2
1		1	1	2	2	2	2	3	3
0	1	1	2	2	2	2	3	3	3
00	1	2	2	2	2	3	3	3	3
000	1	2	2	2	3	3	3	3	3
0000	1	2	2	3	3	3	3	3	4
250	1	2	2	3	3	3	4	4	4
300	1	2	2	3	3	4	4	4	4
350	1	3	3	3	3	4	4	4	5
400	1	3	3	3	4	4	4	5	5
500	1	3	3	3	4	4	5	5	6
600	2	3	3	4	4	5	6	6	6
700	2	3	3	4	5	5	6	6	...
750	2	3	3	4	5	6	6	6	...
800	2	3	4	4	5	6	6	...	...
900	2	4	4	5	6	6	6	...	...

\* Where a service run of conduit or electrical metallic tubing does not exceed 50 feet in length and does not contain more than the equivalent of two quarter bends from and to end two No. 4 insulated and one No. 4 bare conductors may be installed in 1-inch conduit or tubing.

## NUMBER OF CONDUCTORS IN CONDUIT OR TUBING

Lead-Covered Types RL and RHL-600 V.

Size AWG MCM	Number of Conductors in One Conduit or Tubing											
	Single Conductor Cable				2-Conductor Cable				3-Conductor Cable			
	1	2	3	4	1	2	3	4	1	2	3	4
14												
12												
10												
8												
6		1	1	1	1	1	1	1	1	1	1	1
4		1	1	1	1	1	1	1	1	1	1	1
3		1	1	1	1	1	1	1	1	1	1	1
2		1	1	1	1	1	1	1	1	1	1	1
1		1	1	1	1	1	1	1	1	1	1	1
0	1	2	2	2	2	2	2	2	2	2	2	2
00	1	2	2	2	2	2	2	2	2	2	2	2
000	1	2	2	2	2	2	2	2	2	2	2	2
0000	1	2	2	2	2	2	2	2	2	2	2	2
250	1	2	2	3	2	2	2	2	2	2	2	2
300	1	2	2	3	2	2	2	2	2	2	2	2
350	1	2	2	3	2	2	2	2	2	2	2	2
400	1	2	2	3	2	2	2	2	2	2	2	2
500	1	2	2	3	2	2	2	2	2	2	2	2
600	2	3	3	4	3	3	3	3	3	3	3	3
700	2	3	3	4	3	3	3	3	3	3	3	3
750	2	3	3	4	3	3	3	3	3	3	3	3
800	2	3	3	4	3	3	3	3	3	3	3	3
900	2	3	3	4	3	3	3	3	3	3	3	3

## NUMBER OF CONDUCTORS IN CONDUIT OR TUBING

More Than Nine Conductors  
Rubber-Covered Types RF-32, RUF, R, RH, RW, RU, RUW, RW  
Thermoplastic Types TF, T, and TW

Size AWG	Maximum Number of Conductors in Conduit or Tubing						
	1/2 inch	1 inch	1 1/2 inch	2 inch	2 1/2 inch	3 inch	3 1/2 inch
18	12	20	35	49	80	115	176
16	10	17	30	41	68	97	150
14		10	18	25	40	59	90
12			15	21	35	50	77
10			13	17	29	41	64
8				10	17	25	38
6					15	23	35

## DIMENSIONS OF RUBBER-COVERED AND THERMOPLASTIC-COVERED CONDUCTORS

Size AWG MCM	Types RF-32, R, RH, RW		TF, T, TW, RU** RUF, RUW	
	Approx. Diam. Inches	Approx. Area Sq. Ins.	Approx. Diam. Inches	Approx. Area Sq. Ins.
18	.146	.0167	.106	.0088
16	.158	.0196	.118	.0109
14	2/64 in. .171	.0230	.131	.0135
14	3/64 in. .204*	.0327*		
12	2/64 in. .188	.0278	.148	.0172
12	3/64 in. .221*	.0384*		
10	.242	.0460	.168	.0224
8	.311	.0760	.228	.0408
6	.397	.1238	.323	.0819
4	.452	.1605	.372	.1087
3	.481	.1817	.401	.1263
2	.513	.2067	.433	.1473
1	.588	.2715	.508	.2027
0	.629	.3107	.549	.2367
00	.675	.3578	.595	.2781
000	.727	.4151	.647	.3288
0000	.785	.4840	.705	.3904
250	.868	.5917	.788	.4877
300	.933	.6837	.843	.5581
350	.985	.7620	.895	.6291
400	1.032	.8365	.942	.6969
500	1.119	.9834	1.029	.8316
600	1.233	1.1940	1.143	1.0261
700	1.304	1.3355	1.214	1.1575
750	1.339	1.4082	1.249	1.2252
800	1.372	1.4784	1.282	1.2908
900	1.435	1.6173	1.345	1.4208

\*The dimensions of Type RW wire. Also, these dimensions to be used for new work in computing size of conduit or tubing for combinations of wires not shown in table 4.

\*\*No. 14 to No. 2.

No. 18 to No. 8, solid; No. 6 and larger, stranded.

## DIMENSIONS OF LEAD-COVERED CONDUCTORS

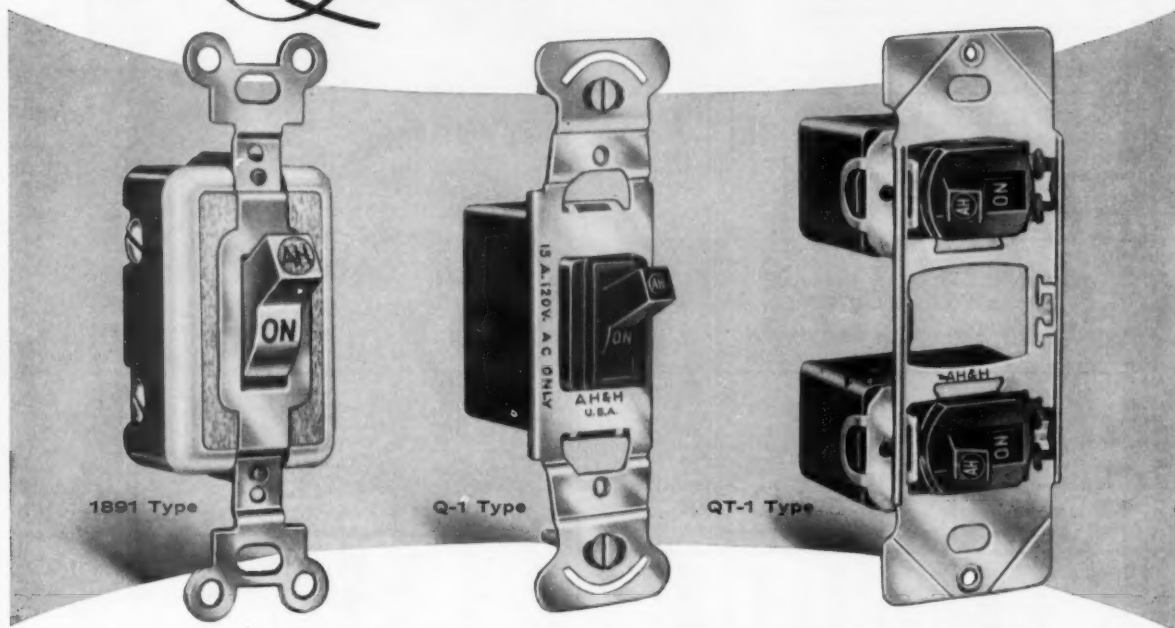
Types RL, RHL, and RUL

Size AWG-MCM	Single Conductor		Two Conductor		Three Conductor	
	Diam. Inches	Area Sq. Ins.	Diam. Inches	Area Sq. Ins.	Diam. Inches	Area Sq. Ins.
14	.28	.062	.28 x .47	.115	.59	.273
12	.29	.066	.31 x .54	.146	.62	.301
10	.35	.096	.35 x .59	.180	.68	.363
8	.41	.132	.41 x .71	.255	.82	.528
6	.49	.188	.49 x .86	.369	.97	.738
4	.55	.237	.54 x .96	.457	1.08	.916
2	.60	.283	.61 x 1.08	.578	1.21	1.146
1	.67	.352	.70 x 1.23	.756	1.38	1.49
0	.71	.396	.74 x 1.32	.859	1.47	1.70
00	.76	.454	.79 x 1.41	.980	1.57	1.94
000	.81	.515	.84 x 1.52	1.123	1.69	2.24
0000	.87	.593	.90 x 1.64	1.302	1.85	2.68
250	.98	.754			2.02	3.20
300	1.04	.85			2.15	3.62
350	1.10	.95			2.26	4.02
400	1.14	1.02			2.40	4.52
500	1.23	1.18			2.59	5.28





# the COMPLETE LINE of *Quiette* LIGHT SWITCHES



1891 Type

Q-1 Type

QT-1 Type

LIFETIME *Quiette* SWITCH

Junior *Quiette* SWITCH

INTERCHANGEABLE *Quiette* SWITCH

## HAS EVERYTHING you . . . and Your Customers . . . want

YOU want features that assure easy, fast, economical installation and maintenance. A-H QUIETTE Light Switches have them — Screwless Wire-Lock Terminals with Easy Wire Release, Strip Gages and Feed Thru Shunts. YOUR CUSTOMERS want quiet, safe, dependable operation of their incandescent and fluorescent lights and appliances. A-H QUIETTE Light Switches provide this through mechanical operation. Contacts are silver alloy for substantial load capacity not mercury type.

**1891 Type** — Specification grade with Binding Screws or Screwless Wire-Lock Terminals. 120-277 volt ac only. 15 or 20 amp sizes.

**Q-1 Type** — With Screwless Wire-Lock Terminals. Ground Feed Thru Shunt in single pole models. 15 amp — 120 volt ac only.

**QT-1 Type** — Interchangeable, Specification grade. With Screwless Wire-Lock Terminals. Line Feed Thru Shunt in single pole and 3-way models. 15 amp — 120-277 volt ac only.

*All are available in single or double pole, 3-way or 4-way, with Brown or Ivorylite handles. Listed as standard by Underwriters' Laboratories.*

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NAME \_\_\_\_\_  
POSITION \_\_\_\_\_  
COMPANY \_\_\_\_\_  
CO. ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_



## 12.0 DATA TABLES (CONTINUED)

**COMBINATION OF CONDUCTORS**  
Per Cent Area of Conduit or Tubing Occupied by Conductors

	Number of Conductors				
	1	2	3	4	Over 4
Conductors (not lead covered) . . . .	53	31	43	40	40
Lead-covered conductors . . . . .	55	30	40	38	35
For rewiring existing raceways for increased load where it is impracticable to increase the size of the raceway due to structural conditions	60	40	50	50	50

**DIMENSIONS OF CONDUIT OR TUBING**

Size	Internal Diameter Inches	Area Square Inches	Size	Internal Diameter Inches	Area Square Inches
1/2	.622	.30	3	3.068	7.38
3/4	.824	.53	3 1/2	3.548	9.90
1	1.049	.86	4	4.026	12.72
1 1/4	1.380	1.50	4 1/2	4.506	15.95
1 1/2	1.610	2.04	5	5.047	20.00
2	2.067	3.36	6	6.065	28.89
2 1/2	2.469	4.79			

**ALLOWABLE CURRENT-CARRYING CAPACITIES OF INSULATED CONDUCTORS IN AMPERES**

Not More Than Three Conductors in Raceway or Cable

(Based on Room Temperature of 30 C. 86 F.)

Size AWG MCM	Rubber Type R Type RW Type RUW (14-2) Thermoplastic Type T Type TW	Rubber Type RH	Paper Thermoplastic Asbestos Type TA Var-Cam Type V Asbestos Var-Cam Type AVB	Asbestos Var-Cam Type AVA Type AVL	Impregnated Asbestos Type AI (14-8) Type AIA	Asbestos Type AA (14-8) Type AA
14	15	15	25	30	30	30
12	20	20	30	35	40	40
10	30	30	40	45	50	55
8	40	45	50	60	65	70
6	55	65	70	80	85	95
4	70	85	90	105	115	120
3	80	100	105	120	130	145
2	95	115	120	135	145	165
1	110	130	140	160	170	190
0	125	150	155	190	200	225
00	145	175	185	215	230	250
000	165	200	210	245	265	285
0000	195	230	235	275	310	340
250	215	255	270	315	335	....
300	240	285	300	345	380	....
350	260	310	325	390	420	....
400	280	335	360	420	450	....
500	320	380	405	470	500	....
600	355	420	455	525	545	....
700	385	460	490	560	600	....
750	400	475	500	580	620	....
800	410	490	515	600	640	....
900	435	520	555	...	...	....
1000	455	545	585	680	730	....
1250	495	590	645	...	...	....
1500	520	625	700	785	...	....
1750	545	650	735	...	...	....
2000	560	665	775	840	...	....

**ALLOWABLE CURRENT-CARRYING CAPACITIES OF INSULATED CONDUCTORS IN AMPERES**

Single Conductor in Free Air

(Based on Room Temperature of 30 C. 86 F.)

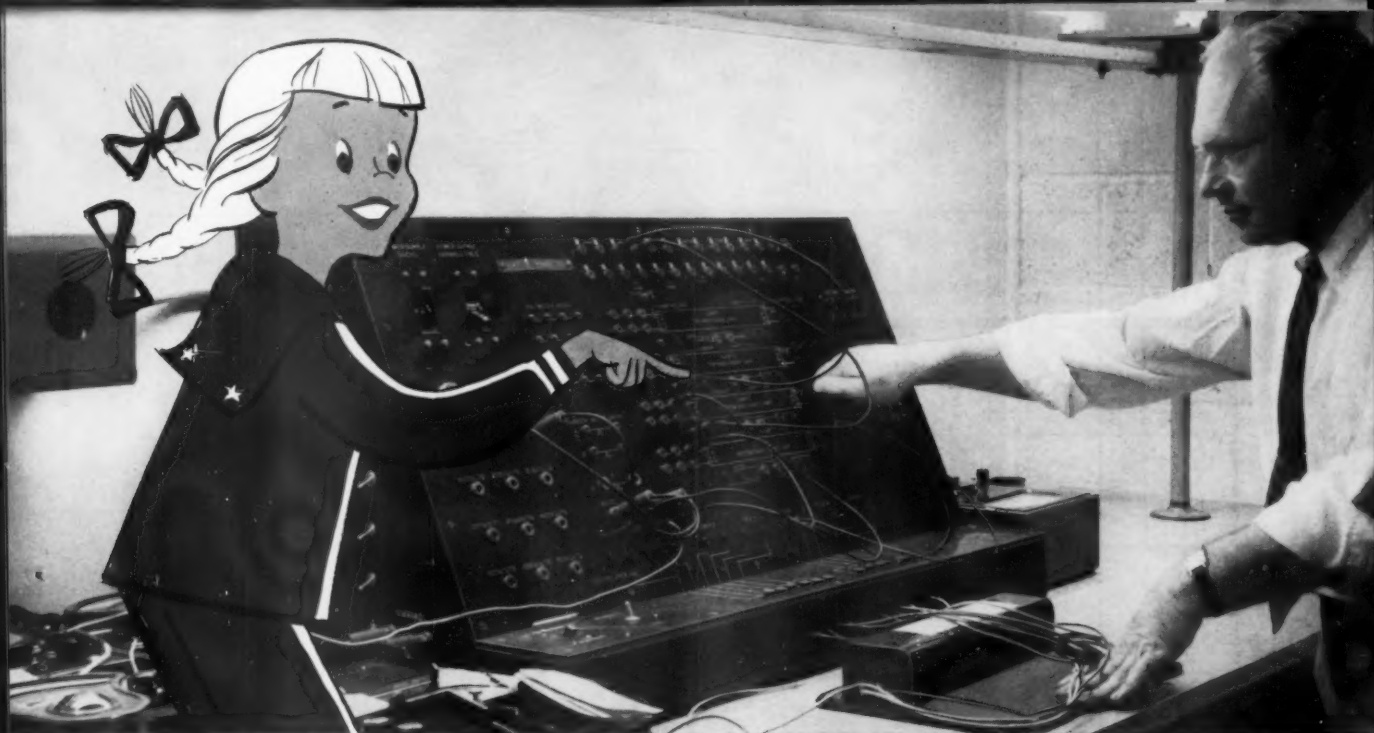
Size AWG MCM	Rubber Type R Type RW Type RUW (14-2) Thermoplastic Type T Type TW	Rubber Type RH	Thermoplastic Asbestos Type TA Var-Cam Type V Asbestos Var-Cam Type AVB	Asbestos Var-Cam Type AVA Type AVL	Impregnated Asbestos Type AI (14-8) Type AIA	Asbestos Type AA (14-8) Type AA	Slow Burning type SB Weather-proof type WP Type SBW
14	20	20	30	40	40	45	30
12	25	25	40	50	50	55	40
10	40	40	55	65	70	75	55
8	55	65	70	85	90	100	70
6	80	95	100	120	125	135	100
4	105	125	135	160	170	180	130
3	120	145	155	180	195	210	150
2	140	170	180	210	225	240	175
1	165	195	210	245	265	280	205
0	195	230	245	285	305	325	235
00	225	265	285	330	355	370	275
000	260	310	330	385	410	430	320
0000	300	360	385	445	475	510	370
250	340	405	425	495	530	....	410
300	375	445	480	555	590	....	460
350	420	505	530	610	655	....	510
400	455	545	575	665	710	....	555
500	515	620	660	765	815	....	630
600	575	690	740	855	910	....	710
700	630	755	815	940	1005	....	780
750	655	785	845	980	1045	....	810
800	680	815	880	1020	1085	....	845
900	730	870	940	...	...	....	905
1000	780	935	1000	1165	1240	....	965
1250	890	1065	1130	...	...	....	...
1500	980	1175	1260	1450	...	....	1215
1750	1070	1280	1370	...	...	....	...
2000	1155	1385	1470	1715	...	....	1405

**CORRECTION FACTOR FOR ROOM TEMPERATURES OVER 30 C. 86 F.**

C.	F.	.82	.88	.90	.94	.95	....
40	104	.82	.88	.90	.94	.95	....
45	113	.71	.82	.85	.90	.92	....
50	122	.58	.75	.80	.87	.89	....
55	131	.41	.67	.74	.83	.86	....
60	140	....	.58	.67	.79	.83	.91
70	158	....	.35	.52	.71	.76	.87
75	167	....	....	.43	.66	.72	.86
80	176	....	....	.30	.61	.69	.84
90	194	....	....	....	.50	.61	.80
100	212	....	....	....	....	.51	.77
120	248	....	....	....	....	....	.69
140	284	....	....	....	....	....	.59

**CORRECTION FACTOR FOR ROOM TEMPERATURES OVER 30 C. 86 F.**

C.	F.	.82	.88	.90	.94	.95	....
40	104	.82	.88	.90	.94	.95	....
45	113	.71	.82	.85	.90	.92	....
50	122	.58	.75	.80	.87	.89	....
55	131	.41	.67	.74	.83	.86	....
60	140	....	.58	.67	.79	.83	.91
70	158	....	.35	.52	.71	.76	.87
75	167	....	....	.43	.66	.72	.86
80	176	....	....	.30	.61	.69	.84
90	194	....	....	....	.50	.61	.80
100	212	....	....	....	....	.51	.77
120	248	....	....	....	....	....	.69
140	284	....	....	....	....	....	.59



EXCLUSIVE ELECTRICAL TESTS provide 100% check of G-E ballasts assuring you of rated output from ballast to lamp. When you buy or

specify General Electric ballasts, you're assured of up to 30% more light and up to 50% longer lamp life. This helps you save lighting dollars.

**Flora\* shows you why . . .**

## G-E Lamp-matched Ballasts Give You Up to 50% More Lamp Life, 30% More Light

The life and light output ratings of fluorescent lamps are based on their use with ballasts which provide the required operating characteristics. General Electric lamp-matched ballasts meet all lamp requirements; in many ways they exceed prescribed lamp and CBM specifications.

An indication of the importance of the ballast to more economical lighting is given in a report issued by the General

Electric Lamp Division which reads in part: "Tests indicate that ballasts which deliver improper values reduce lamp life by as much as 50% and light output by as much as 30%."

To fluorescent lighting users, this means G-E ballasts can save thousands of dollars in lighting costs.

Next time you specify equipment for a fluorescent lighting installation, make

sure you get the best . . . specify General Electric lamp-matched ballasts.

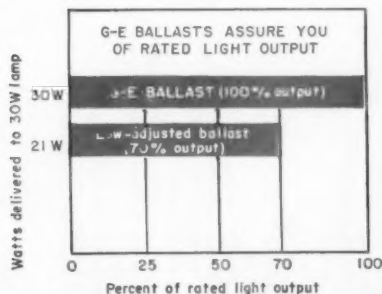
A G-E ballast tag or sticker on your fixture is proof that it's equipped with the best in ballasts. It's the easy way to be certain. For further information on G-E ballasts, write Section 401-14, General Electric Company, Schenectady 5, New York.

\*Miss Fluorescent Ballast, G.E.'s ballast mascot. Copyright 1955, General Electric Company.

### Five more reasons why

#### GENERAL ELECTRIC IS YOUR BEST BALLAST VALUE

- EXCLUSIVE SOUND RATING SYSTEM
- SUPERIOR QUALITY CONTROL
- LONGER BALLAST LIFE
- PROVED PRODUCT LEADERSHIP
- COMPLETE CUSTOMER SERVICES



RESULTS OF A SPECIFIC TEST show that light output can be reduced by as much as 30% when ballasts do not deliver specified electrical values. Specify G.E. for rated output.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

Appliance, Device or Machine	Domestic		Commercial — Industrial		Appliance, Device or Machine	Domestic		Commercial — Industrial	
	Watts	Horsepower	Watts	Horsepower		Watts	Horsepower	Watts	Horsepower
	From To	From To	From To	From To		From To	From To	From To	From To
LIGHTING EQUIPMENT									
Airport Floods			240-3000		Escalators				10-40
Airport Landing Lights			to 1 Kw.		Extractors Steam Laundry				5-20
Blue Printing			3-10 Kw.		Fans, Bracket & Desk	30-100		30-100	
Borderlights, Prof. Stage, per ft.			200-2000		Fans, Ceiling	80-125		80-125	
Borderlights, Schools, per ft.			100-500		Fans, Pedestal	125-300		125-300	
Cave Strips, per ft.	10-200		20-500		Fans, Ventilating 10-in.	35-45		35-45	
Exit Signs			40-150		Fans, Ventilating 12-24 in.		1/40-1/4		1/40-1/4
Floodlights, Outdoor	75-750		200-2000		Fans, Ventilating 30-in. & up				3/8-3
Floodlights, Window			100-1000		Fans, Attic		1/4-1/2		1/4 up
Footlights, Prof. Stage, per ft.			100-1000		Freezers, Food		1/20-1/4		1/4 up
Footlights, Schools, per ft.			100-300		Freezers, Ice Cream	1/8-1/4		1/4-3/4	1/4-3/4
Infrared lamps, per lamp	100-250		250-1000		Grinders, Coffee		1/20-1/4		1/4-1
Luminaires (Commercial Lighting Fixtures)			100-up		Grinders, Meat				1-5
Luminous Tubing (Cold Cathode) per ft.			5-10		Holists, Ash & Cinder				1 1/2-3
Operating Rooms (Hospital)			1-10 Kw.		Holists, Tramrail 1-ton				6-10
Photostat Machines			1-5 Kw.		Holists, Warehouse Loading				1-3
Projectors, Amateur Movie	300-750				Lathes, Home Shop		1/4-1		1-3
Projectors, Amateur Movie and Sound	650-1250				Machines (Floor) Sanding		1/4-1		1-3
Projectors, Prof. Movie			1500-3500	1/4-1	Machines (Floor) Terrazzo		1-5		1-5
Projectors, Visual Lecturing			400-1000		Machines (Floor) Waxing		1/4-1		1/4-1
Reflectors, Show Case, per ft.			10-150		Machines Sewing		1/50-1/20		1/20-1/10
Reflectors, Show Window, per ft.			100-750		Machines Office, Adding				1/20-1/10
Spotlights, Ball Room	100-500		100-2000		Machines Office, Addressing				1/4-1/2
Spotlights, Projection Booth			2750-3300		Machines Office, Billing				1/10-1/2
Spotlights, Stage or Balcony Rail			200-1500		Machines Office, Bookkeeping				1/10-1/2
Spotlights, Show Windows			100-1000		Machines Office, Computing				1/10-1/2
Spotlights, Statuary (Residence)	25-300				Machines Office, Dictation				-1/30
Sterilamps, per ft.	10		10		Machines Office, Record Shaving				1/10-1/6
Vapor, Mercury, High Intensity			250-3000		Machines Office, Sealing & Stamping				1/30-1/10
ELECTRICALLY HEATED EQUIPMENT					Mangles, Laundry				7 1/2-20
Blankets	50-100				Mixers, Beverage	30-100		30-100	5-20
Boilers	1000-1500				Mixers, Dough		1/10-1/4		5-20
Casseroles	100-1000				Mixers, Food		1/10-1/4		1/6-2
Cookers, Food	1200				Mowers, Lawn		1/2-1/2		1/2-1
Dishes, Chafing	160-660				Pumps, Boiler Feed				1-5
Driers, Clothes	1500-5000				Pumps, Brine				2-20
Driers, Hair	200-550	1/4	1-10 Kw.	1/2	Pumps, Drinking Water Circ.				1/2-5
Friers, Deep Fat	1300		300-1200		Pumps, Fire Protection				20-150
Frying Pans	1200		1-2 Kw.		Pumps, Fuel				1/4-3
Heaters, Air	4-9 Kw.		4-9 Kw.		Pumps, Household Water		1/6-1		1/4-3
Heaters, Immersion Type	150-1000		200-2500		Pumps, Milking Machines				1/2-2
Heaters, Organ Chamber	1-3 Kw.		2-10 Kw.		Pumps, Pool & Illum. Fountain				1/4-5
Heaters, Permanent Wave Mach			2-4 Kw.		Pumps, Roof Storage Tank				7 1/2-25
Heaters, panel per sq. ft.	17-50		17-50		Pumps, Sump		1/8-1/2		1/4-3
Heaters, Soil per 60-ft. & 120-ft. Lengths.	400-800				Pumps, Vacuum				2-5
Heaters, Space Elements	1-3 Kw.		1-3 Kw.						
Heat Pumps				1-up					
Heaters, Tank Type Water		1-5	1-5 Kw.	1-up					
Honers, Clothes	1200-3300	1/20-1/4							



Appliance, Device or Machine	Domestic			Commercial — Industrial			Appliance, Device or Machine	Domestic			Commercial — Industrial		
	Watts		Horsepower	Watts		Horsepower		Watts		Horsepower	Watts		Horsepower
	From To	From To		From To	From To			From To	From To				
Irons, Flat . . . . .	500-1200			500-2500			Refrigerators . . . . .			$\frac{1}{8}$ - $\frac{1}{2}$			$\frac{1}{8}$ -2
Irons, Soldering . . . . .	60-500			200-400			Saws, Band (Home Work Shop) . . . . .			$\frac{1}{4}$ - $\frac{1}{2}$			15-25
Irons, Waffle . . . . .	300-1320			1-3 Kw.			Sprayers, Paint & Insecticide . . . . .			$\frac{1}{20}$ - $\frac{1}{4}$			$\frac{1}{4}$ -1
Lamps, Health and Sun . . . . .	30-1500			250-1500			Stage, Curtain Control Motor . . . . .						3-7½
Machines, Vending . . . . .				100-1000			Stage, Orchestra Lift . . . . .						3-10
Machines, Popcorn . . . . .				3-6 Kw.			Stage, Organ Lift . . . . .						½-5
Makers, Coffee . . . . .	450-1200			1-6 Kw.			Stokers, Coal . . . . .			1/6-½			3-15
Ovens, Baking & Roasting . . . . .	660-4000			5-15 Kw.			Tumblers, Laundry Drying . . . . .						
Ovens, Bread & Pie . . . . .				12-55 Kw.			Washers, Clothes . . . . .	300-1800					
Ovens, Industrial Annealing . . . . .				5-30 Kw.			Washers, Dish . . . . .	500-1800					
Ovens, Industrial Enamelling . . . . .				10-100 Kw.			Washers, Steam Laundry . . . . .						
Plates, Hot, Grills, Griddle Tops . . . . .	480-2000			1-6 Kw.			MAGNETS, RECTIFIERS, TRANSFORMERS						
Pots, Glue . . . . .				100-1500			Chargers, Battery . . . . .	600-750					
Ranges . . . . .	5-17 Kw.			8-25 Kw.			Dialthermy, Therapeutic . . . . .						
Roaster . . . . .	1-2 Kw.			1000-3000			Electroplating . . . . .						
Sterilizers, Dental & Doctor . . . . .				2-5.5 Kw.			Furnaces, Induction . . . . .						
Toasters, Bread & Sandwich . . . . .	420-1400			2-6 Kw.			Magnets, Lifting Metal . . . . .						
Waffle Iron . . . . .	1000-1500			4-6 Kw.			Magnets, Metal Extracting . . . . .						
Warmers, Bottle . . . . .	300-600			1-2 Kw.			School Laboratory Panel . . . . .						
Warmers, Cafeteria Food . . . . .				450-1000			Transformers, Bell Ringing . . . . .	25-50					
Warmers, Plate . . . . .	110-500						Transformers, Signal Systems, Relay . . . . .	25-50					
Warmers, Soup & Seafood . . . . .							Valves, Gas & Liquids, 1-in. & Less . . . . .						
MOTOR-OPERATED EQUIPMENT							Valves, Above 1-in. . . . .						
Air Conditioning Systems . . . . .			1-5				Welders, Light Duty Spot & Arc . . . . .						
Automatic Heating Equipment . . . . .			$\frac{1}{8}$ - $\frac{1}{2}$				Welders, Heavy Duty & Arc . . . . .						
Blowers, Organ . . . . .			1-3				X-Ray — Dental & Doctor . . . . .						
Blowers, Pneumatic Tube Systems . . . . .							X-Ray Hospital . . . . .						
Blowers, Portable Cleaning . . . . .							COMMUNICATIONS AND SIGNALLING EQUIPMENT						
Cash Registers . . . . .							Airport Communications . . . . .						
Cleaners, Vacuum Built-in . . . . .			$\frac{1}{2}$ -5				Alarms, Burglar . . . . .	10-60					
Cleaners, Vacuum Portable . . . . .			1/30-¼				Alarms, Fire . . . . .	10-60					
Clippers, Hedge . . . . .			1/30-¼				Amplifiers, Radio Distribution . . . . .						
Compressors, Air (Gasoline Station) . . . . .			$\frac{1}{4}$ -2				Annunciators, Home ⅛ to 2½-in. Lamps, Each . . . . .	1.8-2.4					
Compressors, Air (Temp. Regul. System) . . . . .							Annunciators, Large Systems—(110-Volt Lamps, Each) . . . . .	-10					
Compressors, Refrigeration . . . . .			$\frac{1}{2}$ -1½				Bells, 2½-in. to 4-in. . . . .	5-10					
Conditioners, Air (Room Type) . . . . .			$\frac{1}{8}$ -½				Bells, Larger . . . . .	5-6					
Coolers, Water . . . . .							Buzzers . . . . .	15-25					
Cranes, Travelling Lift . . . . .							Chimes, Door Single and Multiple-Tone . . . . .						
Cranes, Travelling Bridge . . . . .							Chimes, Church Systems . . . . .						
Dehumidifiers . . . . .							Clocks, Master Impulse . . . . .	1-2					
Dental Chair Units . . . . .			$\frac{1}{2}$ -1				Clocks, Secondary Type . . . . .	.5-1					
Disposal Units (Garbage) . . . . .							Gongs, Horns, Howlers . . . . .	10-30					
Door Openers, Private Garage . . . . .							High Fidelity Systems . . . . .	75-500					
Door Openers, Commercial . . . . .			$\frac{1}{8}$ -¼				Radio, Amateur Transmitting . . . . .	100-2000					
Drills, Portable ¼ to ½-in. . . . .			$\frac{1}{4}$ -1				Radio, Home Receivers . . . . .	50-500					
Drills, Portable ½ & Larger . . . . .			$\frac{1}{2}$ -5				Sirens, Small & Heavy-duty . . . . .						1-7½
Dumbwaiters . . . . .			3-10				Television receivers . . . . .	300-1000					1/20-1
Elevators, 1-Ton Freight . . . . .			7½-20				Whistles, Motor Compressor . . . . .						
Elevators, 5-Ton Freight . . . . .			10-50										
Elevators, 10 Pass . . . . .													
Elevators, 25 Pass . . . . .													

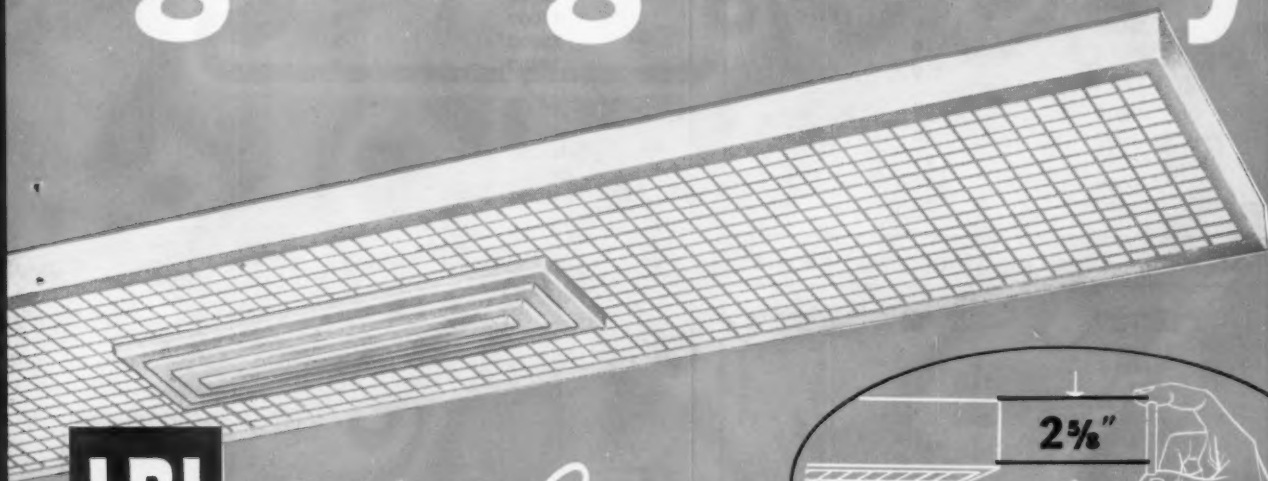
# 12.0 DATA TABLES (CONTINUED)

## CONDUCTOR SIZES AND OVERCURRENT PROTECTION FOR MOTORS

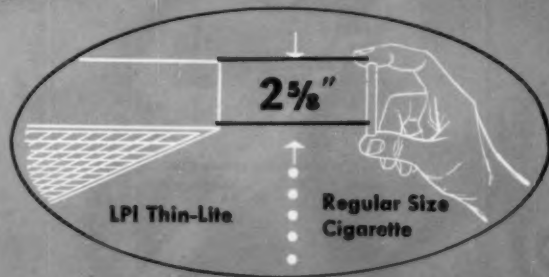
The values shown for running protection in Columns 5 and 6 must be modified if nameplate full load current values are different. Conductor sizes shown in Columns 2 and 3 may be smaller for certain motors. The current values shown in Columns 5 and 6 must be reduced by 8 per cent for all motors other than open type motors marked to have a temperature rise not over 40 degrees C.

Full load current rating of motor amperes Col. No. 1	Minimum size conductor in raceways For conductors in air or for other insulations see tables 1 and 2 AWG and MCM Type R		For Running Protection of Motors		Maximum Allowable Rating or Setting of Branch Circuit Protective Devices				
					With Code Letters Single-phase and squirrel cage and synchronous. Full voltage, resistor and reactor starting, Code letters F to R inc. Without Code Letters Same as above. 7	With Code Letters Single-phase and squirrel cage and synchronous. Full voltage, resistor or reactor starting, Code letters B to E inc. Auto-transformer starting, Code letters F to R inclusive Without Code Letters Squirrel cage and synchronous auto-transformer starting. High reactance squirrel cage. Both not more than 30 amperes 8	With Code Letters Squirrel cage and synchronous auto-transformer starting, Code letters B to E inclusive Without Code Letters Both not more than 30 amperes 9	With Code Letters All motors. Code letter A. Without Code Letters DC and wound-rotor motors 10	
	Maximum rating of non-adjustable protective devices Amperes 5	Maximum setting of adjustable protective device Amperes 6							
			Type T 2	Type RH 3					Amperes 5
1	14	14	2	1.25	15	15	15	15	
2	14	14	3	2.50	15	15	15	15	
3	14	14	4	3.75	15	15	15	15	
4	14	14	6	5.0	15	15	15	15	
5	14	14	8	6.25	15	15	15	15	
6	14	14	8	7.50	20	15	15	15	
7	14	14	10	8.75	25	20	15	15	
8	14	14	10	10.0	25	20	20	15	
9	14	14	12	11.25	30	25	20	15	
10	14	14	13	12.50	30	25	20	15	
11	14	14	15	13.75	35	30	25	20	
12	14	14	15	15.00	40	30	25	20	
13	12	12	20	16.25	40	35	30	20	
14	12	12	20	17.50	45	35	30	25	
15	12	12	20	18.75	45	40	30	25	
16	12	12	20	20.00	50	40	35	25	
17	10	10	25	21.25	60	45	35	30	
18	10	10	25	22.50	60	45	40	30	
19	10	10	25	23.75	60	50	40	30	
20	10	10	25	25.0	60	50	40	30	
22	10	10	30	27.50	70	60	45	35	
24	10	10	30	30.00	80	60	50	40	
26	8	10	35	32.50	80	70	60	40	
28	8	10	35	35.00	90	70	60	45	
30	8	8	40	37.50	90	70	60	45	
32	8	8	40	40.00	100	80	70	50	
34	6	8	45	42.50	110	90	70	60	
36	6	8	45	45.00	110	90	80	60	
38	6	6	50	47.50	125	100	80	60	
40	6	6	50	50.00	125	100	80	60	
42	6	6	50	52.50	125	110	90	70	
44	6	6	60	55.0	125	110	90	70	
46	4	6	60	57.50	150	125	100	70	
48	4	6	60	60.0	150	125	100	80	
50	4	6	60	62.50	150	125	100	80	
52	4	6	70	65.0	175	150	110	80	
54	4	4	70	67.50	175	150	110	90	
56	4	4	70	70.00	175	150	120	90	
58	3	4	70	72.50	175	150	120	90	
60	3	4	80	75.00	200	150	120	90	
62	3	4	80	77.50	200	175	125	100	
64	3	4	80	80.00	200	175	150	100	
66	2	4	80	82.50	200	175	150	100	
68	2	4	90	85.00	225	175	150	110	
70	2	3	90	87.50	225	175	150	110	
72	2	3	90	90.00	225	200	150	110	
74	2	3	90	92.50	225	200	150	125	
76	2	3	100	95.00	250	200	175	125	
78	1	3	100	97.50	250	200	175	125	
80	1	3	100	100.00	250	200	175	125	
82	1	2	110	102.50	250	225	175	125	
84	1	2	110	105.00	250	225	175	150	
86	1	2	110	107.50	300	225	175	150	
88	1	2	110	110.00	300	225	200	150	
90	0	2	110	112.50	300	225	200	150	
92	0	2	125	115.00	300	250	200	150	
94	0	1	125	117.50	300	250	200	150	
96	0	1	125	120.00	300	250	200	150	
98	0	1	125	122.50	300	250	200	150	
100	0	1	125	125.00	300	250	200	150	
105	00	1	150	131.5	350	300	225	175	
110	00	0	150	137.5	350	300	225	175	
115	00	0	150	144.0	350	300	250	175	
120	000	0	150	150.0	400	300	250	200	
125	000	00	175	156.5	400	350	250	200	
130	000	00	175	162.5	400	350	300	200	
135	0000	00	175	169.0	450	350	300	225	
140	0000	00	175	175.0	450	350	300	225	
145	0000	000	200	181.5	450	400	300	225	
150	0000	000	200	187.5	450	400	300	225	
155	0000	000	200	194.0	500	400	350	250	
160	250	000	200	200.0	500	400	350	250	
165	250	0000	225	206.	500	450	350	250	
170	250	0000	225	213.	500	450	350	300	
175	300	0000	225	219.	600	450	350	300	
180	300	0000	225	225.	600	450	400	300	
185	300	0000	250	231.	600	500	400	300	
190	300	250	250	238.	600	500	400	300	
195	350	250	250	244.	600	500	400	300	
200	350	250	250	250.	600	500	400	300	
210	400	300	250	263.	600	600	450	350	
220	400	300	300	275.	600	600	450	350	
230	500	300	300	288.	600	600	500	350	
240	500	350	300	300.	600	600	500	400	

# *It's making* lighting history!



*Thin-Lite*



## *World's Thinnest Shielded Luminaire*

No wonder Thin-Lite is creating such a sensation from coast to coast. Here, at last, is a surface mounted fixture so shallow that its depth below ceiling is essentially the same as that of troffers fitted with dished shields. Thin-Lite actually creates a semi-recessed effect.

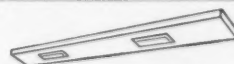
The four different models (right) can be mounted end to end or side by side, in any combination, to form an unlimited variety of lighting patterns up to any desired size. A few suggestions are shown below.

Thin-Lite luminaires feature metal-framed, molded plastic louver panels, secured by LPI's patented floating hinge which cannot be seen from any angle, and which eliminates unsightly latches and fastening devices.

Available through leading electrical wholesalers, Thin-Lite luminaires are wired with standard E.T.L. ballasts.



**THR 240**—49" long, 12 1/4" wide, 2 5/8" thin. Two 48" Rapid Start lamps.



**THS 296**—97" long, 12 1/4" wide, 2 5/8" thin. Two 96" 430 MA. lamps.



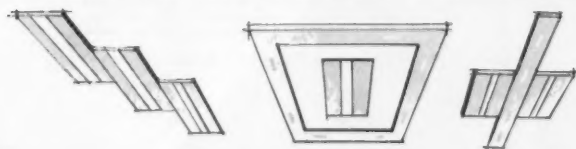
**THR 440**—49" long, 26 3/4" wide, 2 5/8" thin. Four 48" Rapid Start lamps.



**THS 496**—97" long, 26 3/4" wide, 2 5/8" thin. Four 96" 430 MA. lamps.

*Mail Coupon for Detailed Information*

### LIGHTING PATTERNS UNLIMITED



5600

### LIGHTING PRODUCTS INC.

Dept. 4  
Highland Park, Illinois

Please send me a copy of Thin-Lite Brochure No. 530.

Name \_\_\_\_\_ Position \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

## 12.0 DATA TABLES (CONTINUED)

### ISOLATION BY ELEVATION Distance of Live Parts Above the Floor or Other Working Surface

Voltage Between Phases	Minimum Vertical Clearance of Unguarded Parts Feet	Inches
600	8	0
2300	8	0
6600	8	0
11000	9	0
22000	9	3
33000	9	6
44000	9	10
66000	10	5
88000	11	0
110000	11	7
132000	12	2

### WORKING SPACE Minimum Clear Space Adjacent to Live Parts

Voltage Between Phases	Minimum Horizontal Clearance of Unguarded Parts Feet	Inches
600	3	2
2300	3	3
6600	3	4
11000	3	6
22000	3	9
33000	4	0
44000	4	4
66000	4	11
88000	5	6
110000	6	1
132000	6	8

### MAXIMUM NUMBER OF CONDUCTORS IN BOXES

Deep Boxes				
Box Dimensions Trade Size	No. 14	No. 12	No. 10	No. 8
1-1/2 x 3-1/4 octagonal	5	5	4	0
1-1/2 x 4 octagonal	8	7	6	5
1-1/2 x 4 square	11	9	7	5
1-1/2 x 4-11/16 square	16	12	10	8
2-1/8 x 4-11/16 square	20	16	12	10
2 x 1-3/4 x 2-3/4	5	4	4	
2-1/2 x 1-3/4 x 2-3/4	6	6	5	
3 x 1-3/4 x 2-3/4	7	7	6	
Shallow Boxes of Less Than 1 1/4" Depth				
Box Dimensions Trade Size	No. 14	No. 12	No. 10	No. 8
3-1/4	4	4	3	
4	6	6	4	
4-11/16	8	6	6	
Combinations				
Size of Conductor	Free Space Within Box For Each Conductor			
No. 14	2. cubic inches			
No. 12	2.25 cubic inches			
No. 10	2.5 cubic inches			
No. 8	3. cubic inches			

### FULL-LOAD CURRENT\* Single-Phase A-C Motors

HP	115V	230V	440V
1/6	3.2	1.6	
1/4	4.6	2.3	
1/2	7.4	3.7	
3/4	10.2	5.1	
1	13.	6.5	
1 1/2	18.4	9.2	
2	24.	12.	
3	34.	17.	
5	56.	28.	
7 1/2	80.	40.	21.
10	100.	50.	26.

### FULL-LOAD CURRENT\* Three-Phase A-C Motors

Induction Type Squirrel-Cage and Wound Rotor Amps

Synchronous Type 1/Unity Power Factor Amps

### FULL-LOAD CURRENT\* Direct-Current Motors

HP	115V	230V	550V
1/6	4.6	2.3	.....
1/4	6.6	3.3	1.4
1	8.6	4.3	1.8
1 1/2	12.6	6.3	2.6
2	16.4	8.2	3.4
3	24.	12.	5.0
5	40	20.	8.3
7 1/2	58	29.	12.0
10	76.	38	16.0
15	112	56	23.0
20	148	74	31.
25	184	92	38.
30	220	110	46.
40	292	146	61
50	360	180	75
60	430	215	90
75	536	268	111
100		355	148.

\* These values for full-load current are average for all speeds.

HP	110V	230V	440V	550V	2300V	220V	440V	550V	2300V
1/6	4	2	1	.8	—	—	—	—	—
1/4	5.6	2.8	1.4	1.1	—	—	—	—	—
1	7	3.5	1.8	1.4	—	—	—	—	—
1 1/2	10	5	2.5	2.0	—	—	—	—	—
2	13	6.5	3.3	2.6	—	—	—	—	—
3	—	9	4.5	4	—	—	—	—	—
5	—	15	7.5	6	—	—	—	—	—
7 1/2	—	22	11	9	—	—	—	—	—
10	—	27	14	11	—	—	—	—	—
15	—	40	20	16	—	—	—	—	—
20	—	52	26	21	—	—	—	—	—
25	—	64	32	26	7	54	27	22	5.4
30	—	78	39	31	8.5	65	33	26	6.5
40	—	104	52	41	10.5	86	43	35	8
50	—	125	63	50	13	108	54	44	10
60	—	150	75	60	16	128	64	51	12
75	—	185	93	74	19	161	81	65	15
100	—	246	123	98	25	211	106	85	20
125	—	310	155	124	31	264	132	106	25
150	—	360	180	144	37	—	158	127	30
200	—	480	240	192	49	—	210	168	40

For full-load currents of 208 and 200 volt motors, increase the corresponding 220-volt motor full-load current by 6 and 10 per cent, respectively.

\* These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current rating should be used.

† For 90 and 80 per cent P.F. the above figure should be multiplied by 1.1 and 1.25 respectively.





# UNI-BUS

## BUSWAY

*Roller-Smith*  
CORPORATION  
ELECTRICAL SWITCHGEAR  
BETHLEHEM, PENNSYLVANIA

# the **UNI-BUS BUSWAY** system . . . AN ENTIRELY NEW UNMATCHED FOR FLEXIBILITY.

## **UNI-BUS BUSWAY** Saves Time and Money

Now . . . for the first time . . . a low-voltage-drop plug-in and feeder busway that eliminates the need for time-consuming field measurements and costly custom manufacture. With Roller-Smith's new Uni-Bus System, the need for special lengths, elbows and offsets . . . the special job conditions that ordinarily slow down installation, are no longer a problem . . . and the savings in time and money are tremendous!

Uni-Bus busway does it with a multi-purpose *flexible* connector . . . a standard armored cable joining two attachment boxes. This unique connector may be bent in any direction and used with either the copper or aluminum bus bar systems.

## **UNI-BUS BUSWAY** Is Versatile

So versatile is the new Uni-Bus system that no matter *what* the installation requirement, only a few multipurpose accessories are required to fit your needs, less than 10% of the number of units used in any other plug-in and feeder system. Now you can use the Uni-Bus system for many new applications never before possible.

And with the snap-on hanger, quickly-assembled joints and light weight, the installation costs are down to rock-bottom.

## **UNI-BUS BUSWAY** Systems are Easy to Design

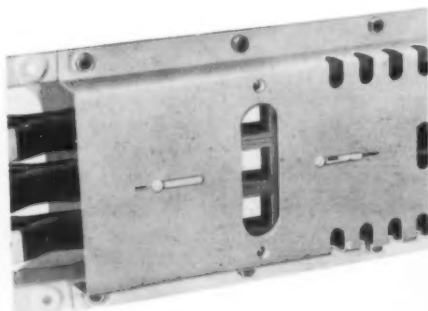
A new freedom from detailed design is now available. The flexible connector takes up the slack due to variations in construction and last-minute changes. Specify the Uni-Bus system as you would conduit and the electrician works out the fittings as he goes along, starting installation at any point.

Uni-Bus fittings are interchangeable and 100% reusable. You can increase or decrease feeder sizes merely by adding or subtracting paralleled runs with assurance of matched performance.

## **UNI-BUS BUSWAY** Is Safe

The new Uni-Bus system incorporates a tremendously important safety feature . . . the "safety-slide" on the plug-in system that eliminates the possibility of accidents and costly shut-downs. No live parts are accessible at any time during installation or removal of Uni-Bus plugs.

### UNI-BUS SAFETY SLIDE



Safety slide can never be opened unless plug is in place covering the opening. There are never any exposed live bus bars. Interlock buttons on each side of plug opening are depressed 1/2-inch by heavy studs on back of plug. Opening safety slide interlocks plug to housing so that it cannot be removed. Slide can be closed when plug is in OFF position as a further assurance that there are no live parts inside the plug. Plug-in system has 12 outlets per 10-foot length and feeder type has two for convenient taps.

### UNI-BUS PLUG



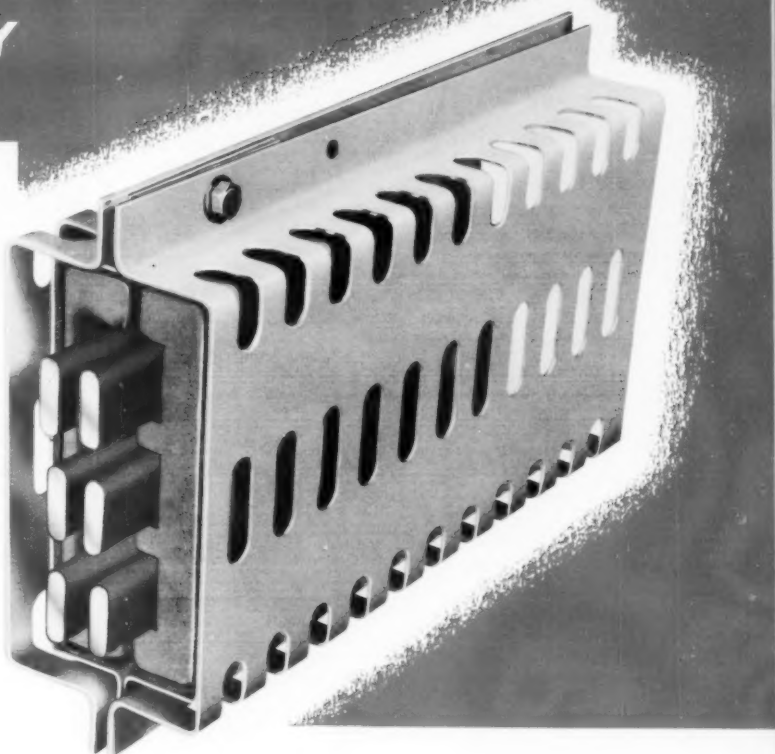
Uni-Bus plugs provide the ultimate in convenience, safety and performance. Simple hangers permit hanging the plug directly onto the busway, completing fastening later. Primary contacts retract into plug housing in open position. Separate primary and secondary switching contacts are interlocked so that circuit is not opened or closed on bus bars. Both contacts are entirely visible in "open" position and are silvered. Fusible and circuit breaker plugs available at lowest price on the market.

# CONCEPT IN POWER DISTRIBUTION

## ECONOMY and SAFETY

### UNIQUE, UNI-BUS FEATURES

- Low voltage drop in both plug-in and feeder systems because of close bus bar spacing and Duo-circuit arrangement.
- High momentary short-circuit strength, up to 50,000 RMS amperes on plug-in and feeder system because of close bus support spacing.
- One housing size for all ratings, 225, 400, 600, 675 and 775 amperes, with copper or aluminum bus bars.
- Larger capacities provided by paralleling standard ratings with matched performance.
- Ventilated housing for maximum conductor efficiency, Bondrite treated for corrosion resistance and durability.
- Plug-in and feeder systems interchangeable for economy and flexibility.



### UNI-BUS HANGER

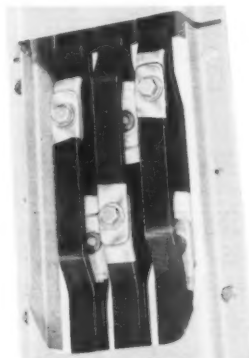
The Uni-Bus clip-on hanger provides unmatched ease and economy. Just snap the hanger onto the Uni-Bus housing at any point. The hooks engage the center ventilating slot and the busway is supported. A clamp bolt may be added if desired as an insurance of positive positioning.

For flat and vertical riser mounting a trapeze type hanger is also available which provides positive support for single or multiple runs.

### UNI-BUS FLEXIBLE CONNECTORS

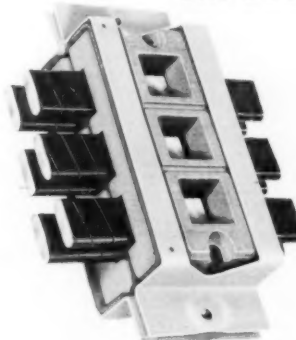


The standard UNI-BUS flexible connector consists of two attachment boxes for joining to straight lengths, with standard armored cable connecting them. This one unit does the work of the many special varieties of elbows, offsets, expansion fittings and transpositions. By removing one of the attachment boxes, the Uni-Bus flexible connector may be used as a combination elbow and switchboard connection for economy and flexibility.



### UNI-BUS JOINTS

Bus bar joints are heavily silver plated for low contact resistance. Aluminum bus bars are specially treated before silver plating to prevent oxidation. Zinc-plated spline nuts, swaged into the bus bars, simplify field installation and reduce installed costs. Identified phase collection straps at the load end of each length provide equalization of load on bus bars and increased short-circuit strength. Ventilated covers over joints on each side provide easy access for quick assembly and prevent excessive temperature rises.



### UNI-BUS BUS SUPPORTS

Bus supports are independent of housing to eliminate damage and on 20-inch centers for high short-circuit strength. Steel brackets cradle the insulators under compression for strength and support bus bars even in vertical riser position. Composition padding of Corprene between brackets, 2-piece porcelain insulators, and bus bars provide a resilient mounting. A heavy insulating compound jackets each bus bar individually for resistance to acids, alkalis, moisture and temperature extremes.

TYPICAL

# UNI-BUS BUSWAY

SPECIFICATION

Furnish and install a complete low-voltage drop busway system of the copper (Aluminum) bus bar type as shown on plans and specified herein. Busway shall be of the UNI-BUS type as manufactured by Roller-Smith Corporation. The contractor shall be responsible for selecting the proper components to provide a complete system from source to load as indicated. The busway system shall have the following minimum short circuit current ratings:

Continuous Rating, Amps.	Short-Circuit Rating RMS Amps.
225-400	25,000
600-775	50,000
800-1550	75,000
1600-4000	100,000

All busways shall be of the low-impedance design to provide minimum voltage drop in accordance with the National Electric Code. All components of the system shall be listed by the Underwriter's Laboratories, Inc. and so labeled. All ferrous parts, including the housing and plugs, shall be treated by the Bonderite process, so labeled, and finished in durable gray enamel. Standard 10-foot straight lengths shall be used whenever possible. All lugs shall be of the solderless type. The system shall operate at its rating without appreciable hum or vibration.

The busway housing shall be of the ventilated sheet steel type and provided with bus supports on maximum 20-inch centers. Bus supports shall be so designed that insulators are separated by an air space from the housing. Ceramic insulators under compression protected by Corprene spacers shall grip the bus bars. The system shall be listed by the Underwriter's Laboratories, Inc. for mounting in the flat, edgewise, or vertical riser position without modification and so labeled. Bus bars

shall be individually enclosed in heavy insulating compound throughout their length except at joint and contact points which shall be silver plated. At least two bus bars per phase shall be provided except for the 225-ampere rating, arranged in duo-circuit configuration for minimum reactance. Identified phase collection straps shall be provided in each length, attached by means of spline nuts swaged into the bus bars at joints but removable in case two circuits in one housing are required. Two zinc-plated bolts per phase per joint shall be provided including lockwashers.

All elbows, offsets, expansion fittings, fire stops, tees, and crossovers shall be made by means of standard flexible connectors.

The feeder and plug-in types shall be interchangeable, regardless of rating. The feeder type shall contain two plug outlets and the plug-in type 12 plug outlets per 10-foot section.

Plug outlets shall consist of a safety-slide which can only be opened or closed when covered by a plug. Plugs shall be arranged so they cannot be removed from the busway except when safety slide is closed.

Plugs shall be of the full interlocking type so arranged that the cover cannot be opened except when all contacts and the external operating handle are in the open position. With the cover open, the open position of all contacts and the position of the safety slide shall be visible. Contacts may not be closed until cover has been closed. Primary contacts shall retract into the plug housing in the open position. Secondary switching contacts shall be of the double break type. All contacts shall be silvered. Interlocks shall be provided so that primary contacts make before the secondary contacts close, break after the secondary contacts open and so that no current is interrupted on the bus bars. Plugs shall be of the "hang-on" type, supported by the busway without final clamping. UNI-BUS plugs shall be of the fusible (molded case circuit breakers) type.

For complete information on the New **UNI-BUS** System and its accessories, write, phone, or wire Electrical Switchgear Division, Roller-Smith Corp., 1000 Eighth Avenue, Bethlehem, Penna.



SYSTEM BY

**Roller-Smith**  
CORPORATION  
ELECTRICAL SWITCHGEAR  
BETHLEHEM, PENNSYLVANIA

*Sold Exclusively through Authorized Electrical Wholesalers*



Armchair convenience comes with enough telephones in the right places.

A telephone in the kitchen is a real time-saver. Saves steps, too.

BUILT-IN CONDUIT

BUILT-IN CONDUIT

Built-in telephone conduit is low in cost. Yet it (1) gives lasting protection to interior beauty, (2) provides the convenience of well-placed outlets, (3) means an extra profit for you.

Include telephone conduits in *all* your home wiring contracts.

Your Bell telephone company will be glad to help you work out economical conduit installations. For details on home telephone wiring, see Sweet's Light Construction File, catalog 8i/Be, or just call your nearest business office. **BELL TELEPHONE SYSTEM**



## 12.0 DATA TABLES (CONTINUED)

### AVERAGE CIRCUIT LENGTHS (FEET) FOR 1% VOLTAGE DROP

AMPERE LOAD	WIRE SIZE—CIRCULAR MILS					WIRE SIZE—B & S or A.W.G.							
	500	400	350	300	250	4/0	3/0	2/0	1/0	1	2	3	4
40	1104	898	788	669	558	475	378	299	239	188	150	119	94
50	885	719	630	535	447	380	303	240	191	150	120	91	75
60	737	599	525	446	372	317	252	200	159	125	100	79	62
70	632	513	450	382	319	271	216	171	136	107	86	68	53
80	553	449	394	334	279	238	189	150	119	94	75	59	47
90	491	399	350	297	248	211	168	133	106	83	67	53	42
100	442	359	315	267	223	190	151	120	95	75	60	47	
110	402	327	284	243	203	173	138	109	87	68	55		
120	369	299	263	223	186	158	126	100	79	63			
130	340	276	242	206	172	146	116	92	73	58			
140	316	257	225	191	159	136	108	86	68				
150	295	240	210	178	148	127	101	80	64				
160	276	225	197	167	140	119	95	75	60				
170	260	211	185	157	131	112	89	70					
180	246	200	175	148	124	106	84	66					
190	235	189	166	140	117	100	80						
200	221	180	157	134	112	95	76						
210	211	171	150	127	106	90							
220	201	163	143	122	101	86							
230	192	156	137	116	97	83							
240	184	150	131	111	93								
250	177	144	126	107	89								
260	170	138	121	100	80								
270	164	133	117	99									
280	158	128	112	96									
290	152	124	109	92									
300	147	120	105										
310	143	116	102										
320	138	112											
330	134	109											
340	130	106											

Calculations based on copper resistance of 12.5 ohms per CM-ft at 50C (122F).

Reactance and impedance losses calculated for each wire.

Conductors closely grouped in metallic conduit.

TABLE III. BALANCED LIGHTING LOADS  
3- and 4-Wire, 115 Volts 1% drop from supply cabinet to first outlet supplying permanently connected appliance or fixture.

AMPERES (A), WATTS (W), WITH CONDUIT CONDUCTOR (C), FILLS (F)						
MAXIMUM OVERCURRENT CIRCUIT PROTECTION	INTERMITTENT LOADS			CONTINUOUS LOADS		
	100% F 2-3 C	80% F 4-4 C	70% F 7-9 C	100% F 2-3 C	80% F 4-4 C	70% F 7-9 C
15 A	15 A 1725 W	12 A 1380 W	10.5 A 1207 W	12 A 1380 W	9.6 A 1104 W	8.4 Amps. 966 Watts
20 A	20 A 2300 W	16 A 1840 W	14 A 1610 W	16 A 1840 W	12.8 A 1472 W	11.2 A 1288 W
LOADS AND LENGTHS IN FEET FOR 1% DROP ON 3 AND 4 WIRE 115 V. CIRCUITS						
AMPERE LOAD	#10 WIRE	#12 WIRE	#14 WIRE			
1	946	596	374			
2	474	298	188			
3	316	198	124			
4	236	148	94			
5	190	120	76			
6	158	100	62			
7	136	86	54			
8	118	74	46			
9	106	66	42			
10	94	60	38			
11	86	54	34			
12	78	50	32			
13	72	46	28			
14	68	42	26			
15	64	40	24			
16	60	38				
17	56	36				
18	52	34				
19	50	32				
20	48	30				
21	46					
22	44					
23	42					
24	40					
25	38					
26	36					
27	34					
28	34					
29	32					
30	32					

Calculations based on copper resistance of 13 ohms per CM-ft at 60C (140F).

Calculations based on copper resistance of 13 ohms per CM-ft at 60C (140F).

AMPERE LOAD	WIRE SIZE—CIRCULAR MILS					WIRE SIZE—B & S or A.W.G.							
	500	400	350	300	250	4/0	3/0	2/0	1/0	1	2	3	4
40	710	625	584	530	475	429	364	303	253	208	173	139	113
50	568	500	467	424	380	343	291	242	203	167	139	111	90
60	473	417	389	353	317	286	243	202	169	139	115	93	75
70	406	357	333	303	271	245	208	173	145	119	99	79	64
80	355	312	292	265	238	214	182	151	127	104	87	69	56
90	316	278	259	235	211	191	162	134	113	93	77	62	45
100	284	250	233	212	190	172	146	121	101	83	69	55	
110	258	227	212	193	173	156	132	110	92	76	63		
120	237	208	195	177	158	143	121	101	84	69	58		
130	218	192	180	163	146	132	112	93	78	64			
140	203	179	167	151	136	123	104	86	72				
150	189	168	156	141	127	114	97	81	67				
160	177	156	146	132	119	107	91	76					
170	167	147	137	125	112	101	86	71					
180	158	139	130	118	106	95	81	67					
190	149	132	123	112	100	90	77						
200	142	125	117	106	95	86	73						
210	135	119	111	101	90	82							
220	129	114	106	96	86	78							
230	123	109	101	92	83	75							
240	118	104	97	88	79								
250	114	100	93	85	76								
260	109	96	90	81	73								
270	105	93	86	78									
280	101	89	83	76									
290	98	86	80	73									
300	95	83	78										
310	92	81	75										
320	89	78											
330	86	76											
340	83	73											
350	81												
360	79												
370	77												
380	75												

Calculations based on copper resistance of 12.5 ohms per CM-ft at 50C (122F).

Reactance and impedance losses calculated for each wire.

Conductors closely grouped in metallic conduit.

#### NOTES:

##### TABLE I:

Balanced 3-Wire Loads: Drop is 1.15 volts for given length.

2-Wire, 230-Volt Loads: Drop is 2.3 volts for given length.

##### TABLE II:

For 208-volt, 4-wire "Y" feeders multiply given length by 0.9

For 230-volt, single-phase feeders multiply given length by 0.85

For 460-volt, 3- or 4-wire feeders multiply given lengths by 2.

For aluminum wire multiply given lengths by 0.7 or use length of copper wire which is 2 sizes smaller than the aluminum size under consideration.

##### TABLE III:

For 2-phase, 3-wire circuits tapped off a 3-phase, 4-wire "Y" service, multiply given lengths by 0.67.

# ROEPLASTIC CONTROL CABLE

Since Roebling pioneered this unique type of cable three years ago sales and repeat orders have skyrocketed—sure proof of outstanding merit.

is for AUTO

When Mommie goes driving  
We go along, too,  
And wave to our friends  
As we're waving to you!

is for BEACH

Come with me! We'll play ball  
And have all sorts of fun,  
Splashing, wading, digging holes,  
And running in the sun.

ORANGE--5--ORA  
BLUE--6--B  
WHITE--7--WH  
BLACK--8--RED BLACK--8

No painted conductor tracers. Conductors are one dark color, each with its IPCEA code color name and its number distinctly printed from end to end with indelible plastic ink which forms an integral part of the insulation and cannot be erased.

**YOU WANT**

FREEDOM FROM ERRORS...  
CONDUCTOR IDENTIFICATION  
THAT IS SIMPLE AS A, B, C  
YET ABSOLUTELY POSITIVE...  
IN SHORT,

**YOU WANT**

# ROEBLING

Subsidiary of The Colorado Fuel and Iron Corporation

JOHN A. ROEBLING'S SONS CORPORATION, TRENTON 2, N. J. BRANCHES: ATLANTA, 934 AVON AVE. • BOSTON, 51 SLEEPER ST. • CHICAGO, 5525 W. ROOSEVELT RD. • CINCINNATI, 3253 FREDONIA AVE. • CLEVELAND, 13225 LAKEWOOD HEIGHTS BLVD. • DENVER, 4801 JACKSON ST. • DETROIT, 915 FISHER BLDG. • HOUSTON, 6216 NAVIGATION BLVD. • LOS ANGELES, 5340 E. HARBOR ST. • NEW YORK, 19 RECTOR ST. • ODESSA, TEXAS, 1920 E. 2ND ST. • PHILADELPHIA, 230 VINE ST. • SAN FRANCISCO, 1740 17TH ST. • SEATTLE, 900 1ST AVE. S. • TULSA, 331 N. CHEYENNE ST. • EXPORT SALES OFFICE, TRENTON 2, N. J.



## SIGNAL SYSTEM CABLES

Rubber and Lead

No. 18—1/64" RL*				No. 18—1/32" RL				No. 16—1/64" RL*				No. 16—1/32" RL			
Over. Diam.	Approx. Area Sq. In.	Thick Lead	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Thick Lead	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Thick Lead	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Thick Lead	Conduit Size
0.56	0.243	4/64"	1"	0.69	0.377	4/64"	1 1/4"	0.61	0.292	4/64"	1"	0.73	0.416	4/64"	1 1/4"
0.70	0.385	4/64"	1 1/4"	0.90	0.636	5/64"	1 1/2"	0.76	0.454	4/64"	1 1/4"	0.96	0.723	5/64"	1 1/2"
0.82	0.528	4/64"	1 3/4"	1.05	0.864	5/64"	2"	0.92	0.665	5/64"	1 1/2"	1.12	0.985	5/64"	2"
0.94	0.680	5/64"	1 3/4"	1.17	1.076	5/64"	2"	1.02	0.817	5/64"	2"	1.28	1.288	6/64"	2"
1.03	0.833	5/64"	2"	1.32	1.367	6/64"	2 1/2"	1.12	0.985	5/64"	2"	1.41	1.563	6/64"	2 1/2"
1.10	0.950	5/64"	2"	1.41	1.563	6/64"	2 1/2"	1.20	1.130	5/64"	2"	1.51	1.791	6/64"	2 1/2"
1.21	1.147	5/64"	2"	1.55	1.885	6/64"	2 1/2"	1.35	1.413	6/64"	2 1/2"	1.66	2.168	6/64"	3"
1.29	1.304	6/64"	2"	1.61	2.035	6/64"	3"	1.40	1.539	6/64"	2 1/2"	1.76	2.435	7/64"	3"
1.33	1.390	6/64"	2 1/2"	1.68	2.199	6/64"	3"	1.46	1.673	6/64"	2 1/2"	1.83	2.631	7/64"	3"
1.42	1.571	6/64"	2 1/2"	1.82	2.592	7/64"	3"	1.55	1.885	6/64"	2 1/2"	1.95	2.985	7/64"	3 1/2"
1.54	1.885	6/64"	2 1/2"	1.98	3.063	7/64"	3 1/2"	1.69	2.246	6/64"	3"	2.12	3.526	7/64"	3 1/2"
1.68	2.199	6/64"	3"	2.15	3.628	7/64"	3 1/2"	1.86	2.717	7/64"	3"	2.34	4.304	8/64"	4"
1.82	2.592	7/64"	3"	2.33	4.265	8/64"	4"	1.99	3.110	7/64"	3 1/2"	2.50	4.909	8/64"	4"
1.93	2.906	7/64"	3"	2.47	4.791	8/64"	4"	2.11	3.495	7/64"	3 1/2"	2.66	5.553	8/64"	4 1/2"

\* Approved by special permission only.

## Signal and Communication Wiring Data

Wire sizes, dimensions and raceway data for types of conductors commonly used on signal, alarm and communication systems. Systems operating at substantial voltages and currents derived from power or lighting circuits are subject to code rules. On low voltage circuits line drop may also become a critically important consideration.

## SINGLE TELEPHONE CABLE

No. Cond.	Single No. 22 & 4 Single No. 18					
	Braided			Leaded		
	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size
6	0.26	0.053	1/2"	0.30	0.071	1/2"
11	0.28	0.061	1/2"	0.33	0.086	1/2"
16	0.31	0.075	1/2"	0.36	0.102	1/2"
26	0.36	0.102	1/2"	0.40	0.126	3/4"
35	0.40	0.126	3/4"	0.45	0.159	3/4"
45	0.44	0.159	3/4"	0.48	0.181	3/4"
55	0.46	0.165	3/4"	0.51	0.204	3/4"
65	0.51	0.204	3/4"	0.55	0.236	1"
75	0.53	0.219	1"	0.59	0.255	1"
85	0.55	0.236	1"	0.60	0.283	1"
100	0.60	0.283	1"	0.64	0.322	1"

## PAIR TELEPHONE CABLE

No. Pairs	Pairs No. 22 & 2 Pairs No. 18						Pairs No. 22 Only					
	Braided			Leaded			Braided			Leaded		
	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size
6	0.36	0.102	1/2"	0.45	0.159	3/4"	0.29	0.066	1/2"	0.33	0.086	1/2"
12	0.41	0.132	3/4"	0.50	0.196	3/4"	0.38	0.133	1/2"	0.42	0.139	3/4"
16	0.50	0.196	3/4"	0.59	0.273	1"	0.42	0.139	3/4"	0.47	0.174	3/4"
22	0.57	0.255	1"	0.66	0.342	1"	0.49	0.188	3/4"	0.53	0.220	1"
32	0.62	0.302	1"	0.71	0.396	1 1/4"	0.57	0.253	1"	0.61	0.292	1"
41	0.74	0.430	1 1/4"	0.85	0.567	1 1/4"	0.61	0.292	1"	0.66	0.342	1"
51	0.88	0.608	1 1/2"	0.97	0.739	1 1/2"	0.70	0.385	1 1/4"	0.76	0.454	1 1/4"
65	0.92	0.665	1 1/2"	1.01	0.802	2"	0.76	0.454	1 1/4"	0.83	0.541	1 1/4"
75	0.95	0.709	1 1/2"	1.03	0.833	2"	0.82	0.528	1 1/4"	0.89	0.622	1 1/4"
85	0.98	0.754	1 1/2"	1.07	0.899	2"	0.86	0.581	1 1/4"	0.93	0.679	1 1/4"
100	1.08	0.916	2"	1.16	1.057	2"	0.94	0.694	1 1/2"	1.01	0.802	1 1/2"
125	1.18	1.094	2"	1.26	1.247	2"	1.01	0.802	1 1/2"	1.08	0.916	2"
150	1.27	1.254	2"	1.34	1.410	2 1/2"	1.12	0.985	2"	1.18	1.094	2"
175	1.37	1.474	2 1/2"	1.44	1.624	2 1/2"	1.18	1.094	2"	1.25	1.227	2"
200	1.45	1.649	2 1/2"	1.57	1.938	3"	1.27	1.254	2"	1.34	1.410	2 1/2"

## DUPLIX &amp; TRIPLEX

Size AWG	Insulation Rubber Braid		Maximum Conductors in Conduit							
			1/2 in. Int. Area .30 Sq. In.		3/4 in. Int. Area .53 Sq. In.		1 in. Int. Area .86 Sq. In.		1 1/4 in. Int. Area 1.30 Sq. In.	
	Over. Diam.	Approx. Area Sq. In.								
22*	.20	.031	6	12	20	36	50	84		
22†	.22	.038	9	15	24	45	60	102		
19*	.24	.045	4	8	14	24	34	68		
19†	.26	.053	6	9	18	33	45	75		

Note: \* 2 Wire twisted.  
† 3 Wire twisted.



Amazing new way  
to provide electric outlets  
*anywhere . . . anytime*

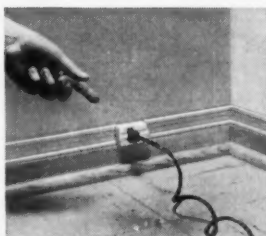
EVERY INCH AN OUTLET!

# BULLDOG ELECTROSTRIP

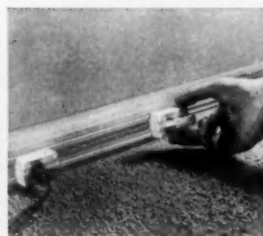
## NEW! DIFFERENT!

New Bulldog Electrostrip® is sturdy wire molding that provides electrical outlets exactly where they are needed, as they are needed—outlets you can move as you move furniture, change lighting arrangements or shift office layouts.

Ideal for modernization or new construction, Electrostrip can be installed easily and quickly on any surface—in any type building. Sold through Bulldog distributors to qualified electrical contractors. Write: Bulldog Electric Products Co., Detroit 32, Mich.



**SIMPLE!** Electrostrip mounts easily on walls, baseboards, floors, anywhere . . . bends to fit any room contour. In shops, stores, homes—new buildings or old—it opens the door to complete freedom from fixed electrical outlets.



**CONVENIENT!** Receptacle plugs clamp into Electrostrip wherever you want them. Outlets can be placed at any spot on the strip . . . moved elsewhere in seconds. Neat and attractive, its natural color harmonizes with any color scheme.



**SAFE!** Bulldog Electrostrip eliminates the hazards of long, dangerous extension cords and overloaded outlets. Receptacle plugs lock securely in position. All wires are enclosed for complete safety. Listed by U. L.

IF IT'S NEW  
... IF IT'S DIFFERENT  
... IF IT'S BETTER ... IT'S

©BEP'CO



**BULLDOG**  
ELECTRIC PRODUCTS COMPANY  
A Division of I-T-E Circuit Breaker Company

Export Division: 13 East 40th Street, New York 16, New York. In Canada: Bulldog Electric Products Company (Canada), Ltd., 80 Clayson Road, Toronto 15, Ontario.

## 12.0 DATA TABLES (CONTINUED)

### SIGNAL SYSTEM CABLES

Rubber Covered

No. Cond.	No. 18—1/64" R*			No. 18—1/32" R			No. 16—1/64" R*			No. 16—1/32" R		
	Over. Diam.	Approx. Area Sq. In.	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Conduit Size
10	0.49	0.188	3/8"	0.61	0.292	1"	0.53	0.219	1"	0.65	0.330	1"
20	0.63	0.314	1"	0.80	0.503	1 1/4"	0.69	0.377	1 1/4"	0.85	0.565	1 1/4"
30	0.74	0.322	1 1/4"	0.94	0.691	1 1/2"	0.81	0.518	1 1/4"	1.01	0.802	1 1/2"
40	0.83	0.541	1 1/4"	1.06	0.880	2"	0.92	0.668	1 1/2"	1.14	1.021	2"
50	0.93	0.675	1 1/2"	1.18	1.094	2"	1.02	0.817	1 1/2"	1.27	1.254	2"
60	1.00	0.785	1 1/2"	1.28	1.288	2"	1.10	0.950	2"	1.38	1.492	2 1/2"
70	1.10	0.950	2"	1.41	1.563	2 1/2"	1.21	1.147	2"	1.53	1.838	2 1/2"
80	1.15	1.037	2"	1.48	1.720	2 1/2"	1.27	1.254	2"	1.60	2.011	3"
90	1.21	1.147	2"	1.54	1.861	2 1/2"	1.32	1.367	2 1/2"	1.67	2.191	3"
100	1.28	1.288	2"	1.66	2.168	3"	1.41	1.563	2 1/2"	1.79	2.513	3"
125	1.40	1.539	2 1/2"	1.82	2.592	3"	1.56	1.909	2 1/2"	1.96	2.974	3 1/2"
150	1.54	1.861	2 1/2"	1.99	3.110	3 1/2"	1.70	2.260	3"	2.15	3.628	3 1/2"
175	1.66	2.168	3"	2.14	3.596	3 1/2"	1.83	2.631	3"	2.31	4.163	4"
200	1.77	2.458	3"	2.28	4.084	4"	1.95	2.984	3 1/2"	2.47	4.791	4"

\* Approved by special permission only.

### GROUPED SINGLE CONDUCTORS

Size AWG	Insulation RF 32, R, RH, RW*		Insulation TF, T, TW, RU*		Insulation RF-64**		Maximum Number Conductors in Conduit									
	Over. Diam.	Ap- prox. Area Sq. In.	Over. Diam.	Ap- prox. Area Sq. In.	Over. Diam.	Ap- prox. Area Sq. In.	1/2 In. Int. Area Sq. In.	3/4 In. Int. Area Sq. In.	1 In. Int. Area Sq. In.	1 1/4 In. Int. Area Sq. In.	1 1/2 In. Int. Area Sq. In.	2 In. Int. Area Sq. In.	2 1/2 In. Int. Area Sq. In.	3 In. Int. Area Sq. In.		
18	.146	.0167	.106	.0088			7	12	20	35	49	80	115	176		
16	.158	.0196	.118	.0109	.100	.0079	14	24	42	73	100	165	236	364		
14	.171	.0230	.131	.0135	.113	.0100	12	19	33	58	79	131	186	287		
12	.188	.0278	.148	.0172			4	6	10	18	25	40	59	90		
10	.242	.0460	.168	.0224			3	5	8	15	21	35	50	77		
8	.311	.0760	.228	.0408			2	4	7	13	17	29	41	64		
6	.397	.1238	.323	.0819			1	3	4	7	10	17	25	38		
4	.475	.1547	.400	.1075			1	1	3	4	6	9	15	23		

Combination of Conductors																							
*								**															
1—No. 14 Equal to								1—No. 18 or 1 No. 16								3—No. 18 or 2 No. 16							
2— " " " "								2— " " " "								5— " " " "							
3— " " " "								4— " " " "								8— " " " "							
1— " 12 " "								1— " " " "								3— " " " "							
2— " " " "								3— " " " "								7— " " " "							
3— " " " "								4— " " " "								10— " " " "							

\*In accordance with  
Note: NEC.

\*\*Approved by special  
permission.

(Above sizes apply to  
straight runs or with nominal  
offsets equivalent to not more  
than two quarter-bands

Note: \*In accordance with NEC.  
\*\*Approved by special permission.

(Above sizes apply to straight runs or with nominal offsets equivalent to not more than two quarter-bends)

### PAGING SYSTEM CABLES

No. Cond.	No. 14—3/64" R			No. 12—3/64" R			No. 14—3/64" RL			No. 12—3/64" RL		
	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Thick Lead	Over. Diam.	Approx. Area Sq. In.	Thick Lead
12	0.84	0.554	1 1/2"	0.94	0.680	1 1/2"	0.97	0.738	5/64"	1 1/2"	1.05	0.864
20	1.10	0.950	2"	1.19	1.112	2"	1.20	1.130	5/64"	2"	1.32	1.367
24	1.21	1.147	2"	1.31	1.348	2"	1.35	1.420	5/64"	2 1/2"	1.45	1.649

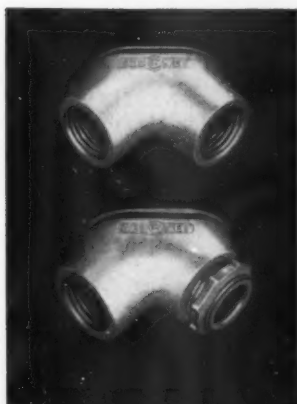
## GRAPHICAL SYMBOLS For Air Conditioning System Components

	Capillary Tube
	Compressor
	Condenser, Air Cooled, Finned, Forced Air
	Condenser, Air Cooled, Finned, Static
	Condenser, Water Cooled Concentric Tube in a Tube
	Condenser, Water Cooled Shell and Coil
	Condenser, Water Cooled Shell and Tube
	Cooling Tower
	Evaporative Condenser
	Evaporator, Manifolder, Finned, Forced Air
	Motor-Compressor, Sealed Crankcase, Reciprocating
	Thermostat (Remote Bulb)
	Valve, Automatic Expansion
	Valve, Hand Expansion
	Valve, Compressor Suction Pressure Limiting, Throttling Type (Compressor Side)
	Valve, Check
	Valve, Diaphragm
	Valve, Gate
	Valve, Globe

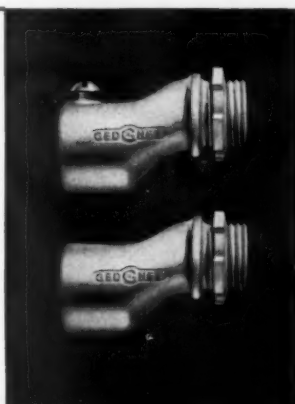
# FOR ROCK-BOTTOM INSTALLATION COSTS *SPECIFY GEDNEY!*

GEDNEY FITTINGS are machined and threaded with utmost accuracy... smooth-finished, with no metal particles or burrs... made of malleable iron to eliminate breakage... individually inspected to

ensure absolutely top quality. That's why they're quickest, least costly to install... Specify Gedney Fittings and you'll find, like thousands of others, that this is the most profitable line available today!



**Gedney 90° Pull-In Ells and Adapters** with Neoprene gasketed cover and self-retaining screws. These fittings may be used to convert a straight box connector into a 90° connector, or as a 90° box connector for rigid standard pipe coupling. Ells have female threads at both ends. Adapters have male threads at one end and female at the other. Made of malleable iron and cadmium plated. Sizes  $\frac{1}{2}$ " to 2".



**Gedney Offset Connectors**—eliminate the necessity for offsetting conduit at knockout entrances of standard boxes. Threaded for rigid, set screw for EMT. Made of malleable iron, cadmium plated, in sizes from  $\frac{1}{2}$ " to 2".



**Gedney Corner Pull-In Elbows** are outstanding for space saving, machine wiring, easy wire pulling. Malleable iron, cadmium plated. Made in  $\frac{1}{2}$ ",  $\frac{3}{4}$ ", 1", 1 $\frac{1}{4}$ ", 1 $\frac{1}{2}$ " and 2" sizes.



**Gedney Offset Coupling**—female both ends—for use as an offset between boxes. Can also be used with conduit nipple (Gedney 7-50 series) to give more room in box than otherwise possible.  
**Gedney Offset Nipple**, male both ends.

Both of these fittings are made of malleable iron, cadmium plated. Available in sizes from  $\frac{1}{2}$ " to 2".



**GEDNEY**  
ELECTRIC COMPANY



RKO BLDG. • RADIO CITY • NEW YORK 20  
Foundry, Factory and Shipping Point: Terryville, Conn.

**GEDNEY FITTINGS FIT**

# Advertisers' Product Index

ELECTRICAL CONSTRUCTION & MAINTENANCE • MAY, 1955

The listings under major product headings are of manufacturers advertising those products in this issue in sufficient detail to be of value to specifiers or users of those products.

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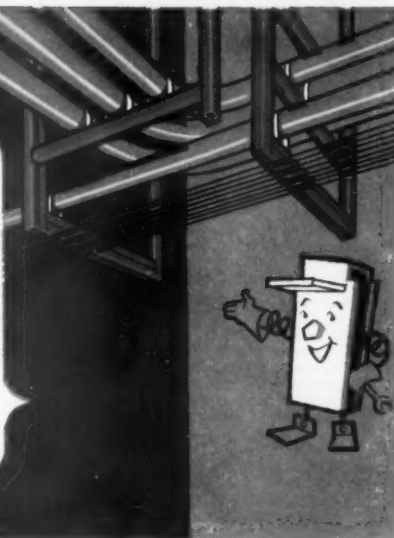
# "The Sky's The Limit"

—when you build with UNISTRUT®

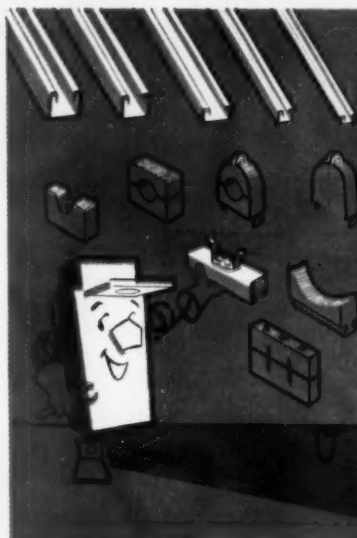


## Mr. Strut shows way to save space, money on conduit racking with UNISTRUT® framing

● This conduit installation was recently done in an industrial plant with UNISTRUT framing. It was a complicated task to arrange the many different lines, but UNISTRUT framing did it fast and kept costs low. This is how it was done—



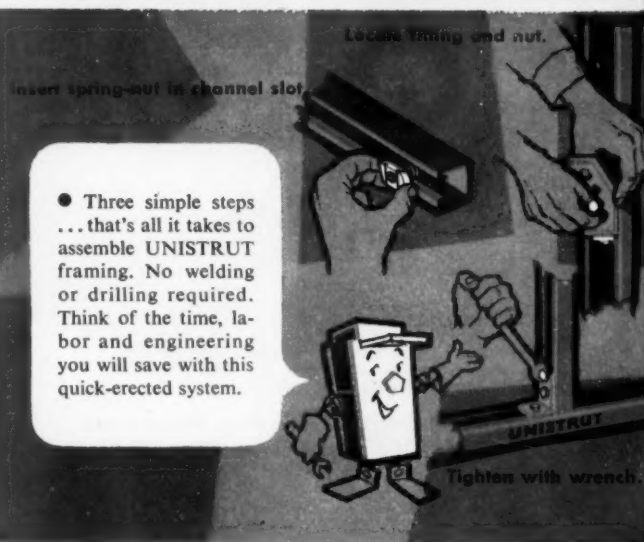
● UNISTRUT framing reduced installation time because everything needed—channels, clamps, insulators, fittings, concrete inserts—are part of the complete UNISTRUT system. No special fabrication needed.



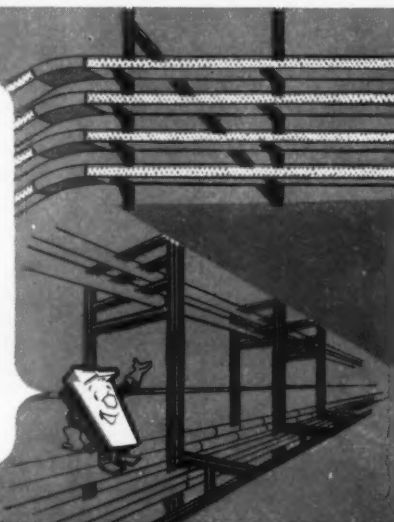
● Here you see how the concrete insert makes installation easy and fast. It provides a fastening point all along its length. Fittings can be attached quickly and adjustments made while work progresses. Everything bolts together. Much easier than welding!



● Three simple steps... that's all it takes to assemble UNISTRUT framing. No welding or drilling required. Think of the time, labor and engineering you will save with this quick-erected system.



● And UNISTRUT framing is ideal for all types of conduit racking. Here you see cable trays and wall racking in a power plant. With this system you can make changes or additions at any time. You can even disassemble and use it over and over as supports or frames for almost anything.



Get acquainted with UNISTRUT framing for your next job. Your UNISTRUT Distributor can be of great assistance in the use and application of UNISTRUT framing for conduit racking. See him, too, for the many other uses of this versatile metal framing system. And be sure to ask about our new low prices!

Mail the coupon below or contact your UNISTRUT Distributor for free catalogs and information on our new idea-packed film: "The Sky's The Limit." Complete warehouse stocks in all principal cities. In Canada, Northern Electric Company.

### The World's Most Flexible All-Purpose Metal Framing



UNISTRUT PRODUCTS COMPANY  
1012 W. Washington Blvd.  
Chicago 7, Illinois

Dept. B-3

- ☐ mechanical and electrical catalog No. 700  
☐ information on UNISTRUT film, "The Sky's The Limit."

Name.....  
Address.....  
Company.....  
City..... Zone..... State.....

U. S. Patent  
Numbers

2327587 2388370  
2329815 2405631  
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Other patents pending

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# PRECISION on your transformer is more than a name ...it's a guarantee!



## Full Rated Load

Carry full loads continuously . . . capable of handling emergency over-loads.



## Economical

Low initial cost . . . inexpensive operation and maintenance.



## Dependable

Ruggedly constructed to exceed latest NEMA standards!



## Quiet

Unsurpassed for smooth, silent operation.

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Manufactured products bearing the trademark or name-plate of this company have been thoroughly inspected and are guaranteed to be free from defects in workmanship or materials. The Company's liability under this guarantee is limited strictly to replacing without charge or repairing upon return to the factory, transportation charges prepaid, any part or parts which within five (5) years from date of shipment from our factory, shall be found to have defective workmanship or material or otherwise fail to meet specifications. We are not responsible for repairs or replacements made by others without our written authorization.



SINGLE AND 3 PHASE  
1/4 to 1500 KVA . . . Voltages to 15 KV.

Available with any make switchgear in substation units.

Write today for FREE Catalog and valuable technical data charts.

## Easy to Service

New handy panel board gives quick access to all taps.



# PTC

## PRECISION TRANSFORMER CORP.

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## Service Entrance Equipment & Accessories

Adam Electric Co., Frank	182, 183
Clark Controller Co., The	208
General Electric Co. (Trumbull Components Dept.)	28, 29
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Diamond Wire & Cable Co.	242
duPont de Nemours & Co., Inc.	233, 299
General Cable Corp.	47, 230, 231
General Electric Co. (Construction Materials Div.)	Fourth Cover, 180, 181
Graybar Electric Co., Inc.	68, 188, 189
Lint Clyde W.	274
Okonite Co., The (Hazard Insulated Wire Works Div.)	43
Page Steel & Wire (Div. of American Chain & Cable)	310
Paranite Wire & Cable (Div. of Essex Wire Corp.)	227
Phelps Dodge Copper Products Corp.	16, 17
Rockbestos Products Corp.	30
Roebbling's Sons Corp., John A.	155
Rome Cable Corp.	198, 199
Simplex Wire & Cable Co.	221
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## If it's electrical, your problem ends at this counter...

No matter what the apparatus requirement, your nearby Westinghouse distributor can meet it... completely and promptly.

He offers full product lines... coordinated Westinghouse equipment that features both simplified and standardized design. These mean faster installation time... easier and more economical maintenance.

And your Westinghouse distributor can readily supply complete stocks from centralized warehousing facilities. This means undivided responsibility... prompt delivery. You make one call, one stop.

**Check the next six pages for examples of the product lines available through your Westinghouse distributor.** →

DP-5014-A

YOU CAN BE SURE...IF IT'S  
**Westinghouse**

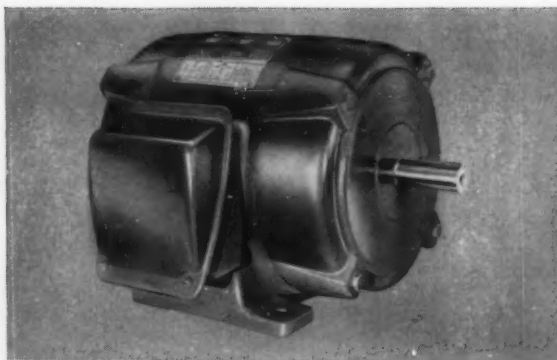




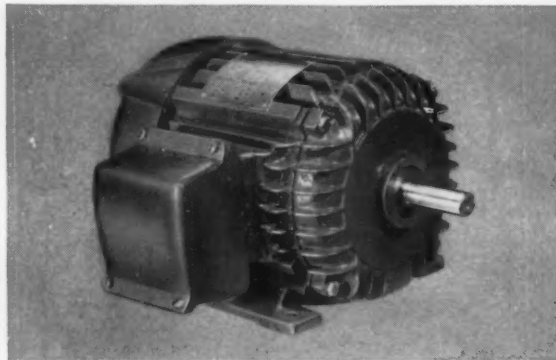
## MOTORS

**New Life-Line® "A" Standard Drip-proof Motor**—a power package guaranteeing better performance. A better protected motor that is smaller, yet stronger electrically than *any* conventional motor on the market. Its improved electrical, mechanical and lubrication systems assure longer motor life and greater operating economy.

**New Life-Line "A" Totally-Enclosed, Fan-Cooled Motor**—has all inherent features of the drip-proof motor, with additional design features that make its application almost universal. Fortified insulation and corrosion-proof motor parts provide new protection against water, oil and chemicals—in either liquid or vapor form.



LIFE-LINE® "A" STANDARD DRIP-PROOF MOTOR



LIFE-LINE "A" TOTALLY-ENCLOSED, FAN-COOLED MOTOR



## MOTOR CONTROL

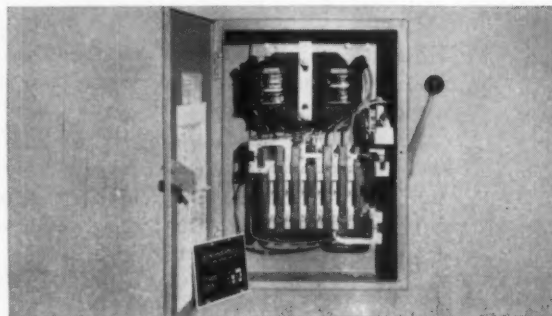
**Control Center**—a group of standardized structures that house motor starters, circuit protective equipment, auxiliary and pilot devices for motor operation. This makes possible a compact, safe, attractive and centralized control system—resulting in better motor control and greater savings.

**New Type MB Autostarter**—the *only* reduced voltage starter with *air break contacts* through all ratings. Applicable wherever maximum starting torque is required with limited-current inrush. *Visual signal* indicates when timing sequence is complete—eliminating incomplete starts. Performance-proven *Type MW overload relays* provide reliable motor protection.

DP-5014-B

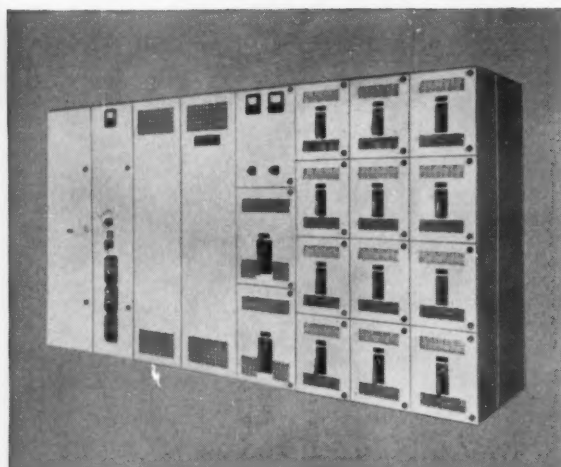


CONTROL CENTER



NEW TYPE MB AUTOSTARTER

YOU CAN BE **SURE**...IF IT'S

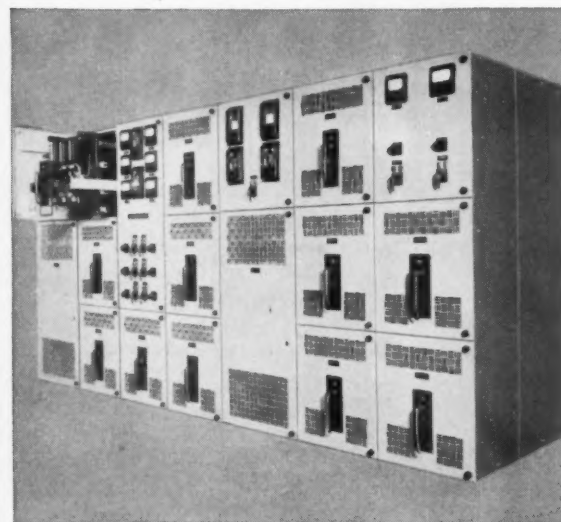


POWER CENTER



## POWER CENTERS

**Power Center**—factory-assembled combinations of transformers, high- and low-voltage switchgear. Especially designed and coordinated for stepping down incoming high-voltage service, distributing it to lower voltage power and lighting load areas. It is totally enclosed, completely safe. Can be placed in center of load areas—eliminating both long feeders and voltage-loss problems.

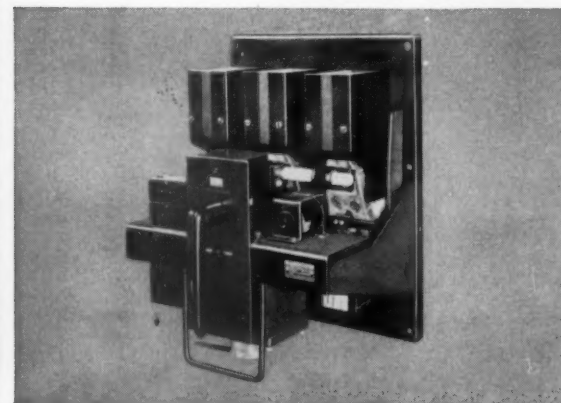


DRAWOUT SWITCHBOARD



## DISTRIBUTION SWITCHBOARDS

**Drawout Switchboard**—completely enclosed, self-contained structure of circuit breakers and associated equipment. Designed for housing power and lighting networks, power feeders, lighting feeders, power generation and auxiliaries. Completely safe. Easy to maintain. Circuit breakers can be drawn out of operating position, automatically disconnecting the circuit. No exposed live parts.



DB BREAKER



## AIR CIRCUIT BREAKERS

**DB Breaker**—for 600 volts and above. Ideal as additional service entrance equipment—resulting from power modernization. Or for location at various points in a system to serve separate load areas. Units can be operated manually or electrically. Available from 15 to 4000 amperes. Maximum interrupting capacity of 100,000 amperes.

DP-5014-C

# Westinghouse

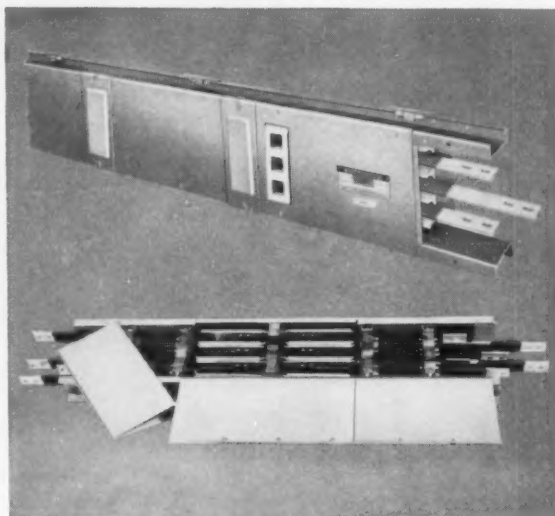




## BUS DUCT

**Aluminum Plug-In Bus Duct**—lighter, easier to handle and install. Rating for rating, it weighs about one-third less than bus duct with copper bus bars. And retains all inherent advantages of copper bus duct: flexibility, safety and economy. All parts are salvageable in plant change-overs.

**Adjustable Straight-Length Bus Duct**—permits a plus or minus adjustment up to six inches, and in any fraction of an inch. Available in *all* ratings of plug-in and indoor low-impedance duct with two bars per phase. Copper or aluminum bus bars.



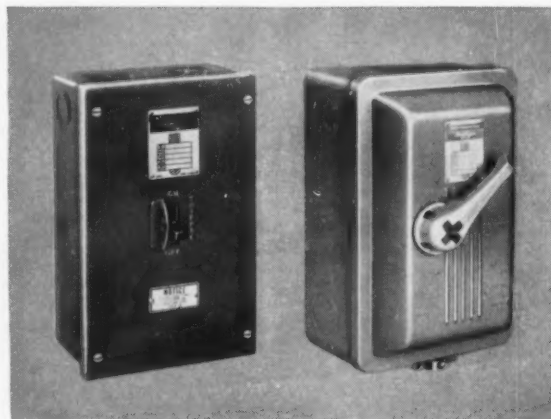
ALUMINUM PLUG-IN BUS DUCT  
ADJUSTABLE STRAIGHT-LENGTH BUS DUCT



## AB-I CIRCUIT BREAKERS

**AB-I (NEMA 1)**—a general-purpose device, primarily for commercial applications. In E, F and J-frame AB breakers. Special services available, including provision for locking in "on" or "off" position, cover pilot light indicator, flush mounting.

**AB-I (NEMA 1A)**—has a wide range of industrial applications. Neoprene gasket assures resistance to dust and other foreign particles. Available from 15 through 600 amperes. Spells low maintenance, less down time and long-range economy.



AB-I (NEMA 1)

AB-I (NEMA 1A)

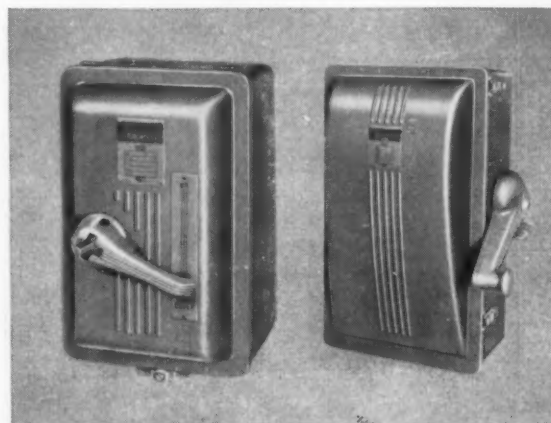


## SAFETY SWITCHES

**Motor Circuit Switch**—a visible-blade disconnect switch, in an enclosure. Designed for heavy industrial applications. Switch is available in 3 pole or 4 pole, solid neutral, in ratings of 30, 60, 100 and 200 amperes. All units unfused only.

**Type "H" Safety Switch**—designed for heavy-duty industrial applications where safety and reliable performance under the most severe conditions are the prime consideration. Switch has a NEMA 1A enclosure, plus a quick-make, quick-break mechanism. Cover is interlocked . . . cannot be opened when switch is in the "on" position.

DP-5014-D

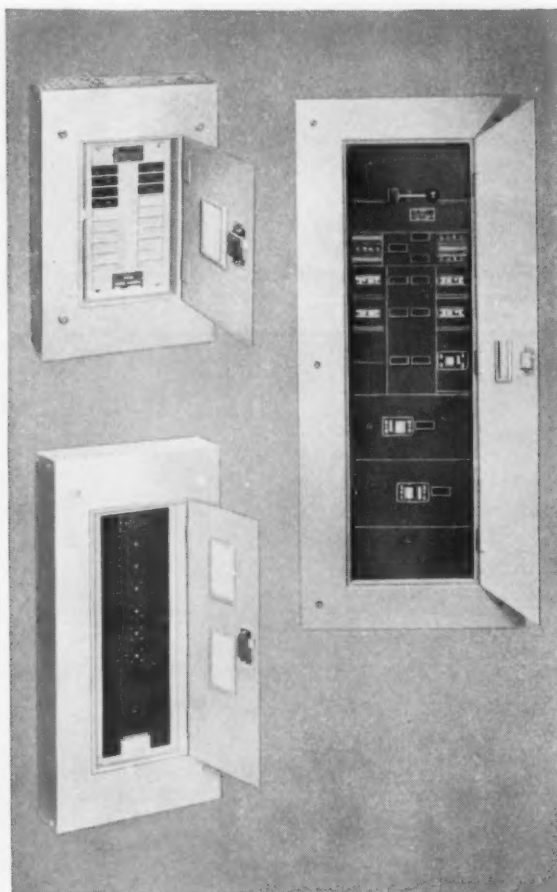


MOTOR CIRCUIT SWITCH

TYPE "H" SAFETY SWITCH

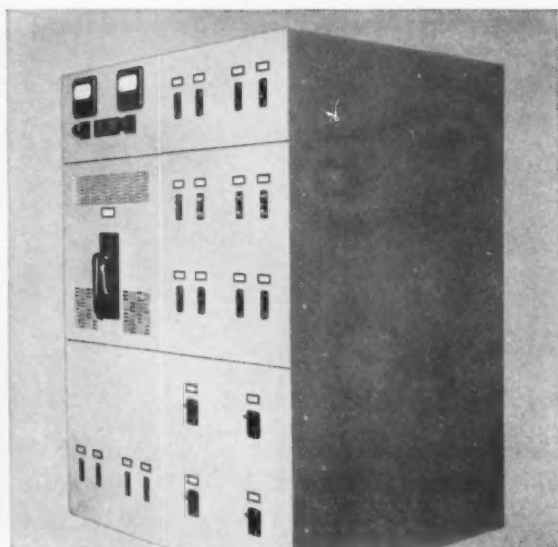
YOU CAN BE SURE...IF IT'S





ADD-A-CIRKIT PANELBOARD  
TYPE NPLB PANELBOARD

TYPE CDP PANELBOARD



BUILDING-TYPE DISTRIBUTION SWITCHBOARD



## PANELBOARDS

**Add-A-Circuit Panelboard**—designed to provide a group of quality components from local stock. Panel-base assembly and box packaged as one unit. Circuit breakers, plus flush and surface type fronts with doors, packaged separately—permitting easy, on-the-job panel assembly to meet specific requirements.

**Type NPLB Panelboard**—new, factory assembled, for lighting and appliance circuits. Offers maximum, low-cost protection through new Westinghouse AB circuit breaker. Retains all construction features of other Westinghouse panelboards: permanent visible branch circuit and phase identification; quick-make, quick-break breaker mechanisms; snap-on covers over neutral bars and main lugs.

**Type CDP Panelboard**—Convertible distribution panelboards with designed-in flexibility. Easily accommodates change-overs to meet modern industrial requirements. Circuit rearrangements can be made quickly and economically. Buses and back pan are drilled and tapped to accommodate any breaker from 15 amperes, 1 pole, to 600 amperes; 3 pole, up to 600 volts a-c.



## BUILDING-TYPE SWITCHBOARDS

**Building-Type Distribution Switchboard**—designed for use in commercial buildings. Compact, factory-assembled units. Delivered ready for installation. Circuit protective devices totally enclosed, eliminating electrical hazards inherent in outmoded, open-front switchboards. Available in any combination of circuit breakers from 15 to 4000 amperes.

DP-5014-E



Westinghouse 



LIGHTING

COMMERCIAL

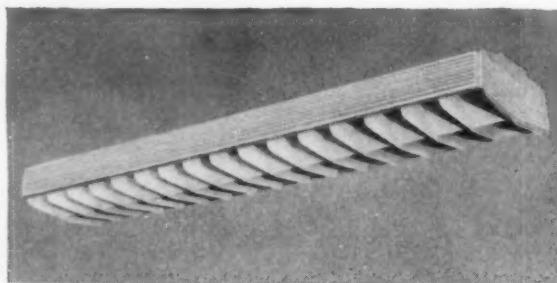
**LC Fluorescent**—provides high illumination levels in all parts of the room. Ideal for office and work areas. A direct-indirect type, giving a diffused, efficiently utilized light. Available with plastic or metal side panels . . . in two- or four-lamp, four- or eight-foot lengths . . . 30° or 45° louvers.

**SC Fluorescent**—designed specifically for shallow surface mounting applications, with a high-level, semi-direct surface illumination. Unit can be suspended, resulting in a uniform level of direct-indirect illumination. Available in two- and four-lamp, four-foot units, with translucent plastic side panels, companion incandescent spotlights.

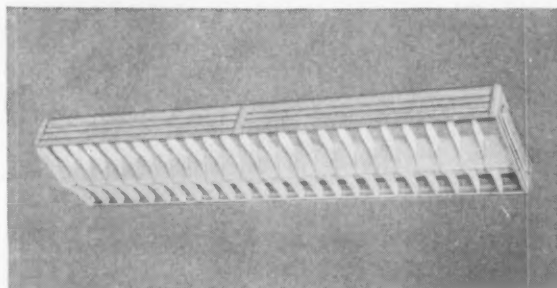
**TU Troffer Fluorescent**—recessed lighting fixture that blends with any architectural design, fits all ceiling patterns. Available in two- and three-lamp; two, four and eight-foot lengths. With 30° or 45° louvers. Or various glass or plastic panels. Shallow depth of troffer minimizes installation problems.

**CR Incandescent**—provides a quality lighting level at an economical initial cost. All light is directed at the ceiling. Flared louver rings shield the silver bowl lamp to eliminate all glare and shadows. Available for ceiling or suspension hanging.

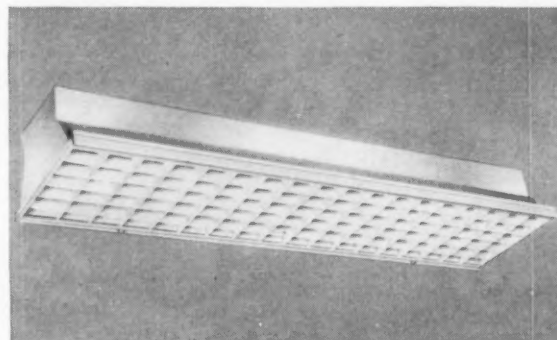
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LC FLUORESCENT



SC FLUORESCENT



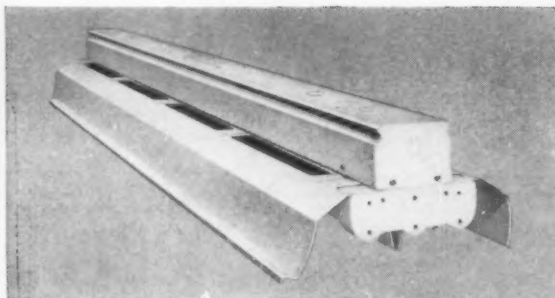
TU TROFFER FLUORESCENT



CR INCANDESCENT



YOU CAN BE **SURE**...IF IT'S



RLM UPWARD COMPONENT



FPC FLUORESCENT



LOCKLITE® INCANDESCENT



VENTILATED ALUMINUM HIGH-BAY



MILLITE®



LIGHTING

INDUSTRIAL

**RLM Upward Component**—produces the highest illumination levels with excellent distribution, brightness control and shielding. Faster and more accurate work, greater safety and comfort result. Lightweight channel and adjustable slide hangers make installation faster and easier.

**FPC Fluorescent**—provides quality light at maximum light output—minimizing number of units required. Designed for general area illumination. May be arranged in continuous rows or as individual units. Available in two- and four-lamp, 5- and 10-foot lengths.

**Locklite® Incandescent**—an ideal industrial incandescent unit. Especially suitable for storerooms, utility areas, and corridors or passageways. One-piece design and patented lock-in arrangement assure long life and easy maintenance.

**Ventilated Aluminum High-Bay**—designed for use with incandescent and mercury lamps. This permits selection of proper lighting pattern and illumination level for the application required. Unique construction of fixture assures high maintained efficiency with low maintenance, long fixture life.

**Millite®**—a completely enclosed luminaire for either inside or outdoor use. Provides a choice of light distribution to match different mounting heights. Especially suitable for heavy industrial areas where protection of the lighting fixture is a consideration.

DP-5014-G

# Westinghouse



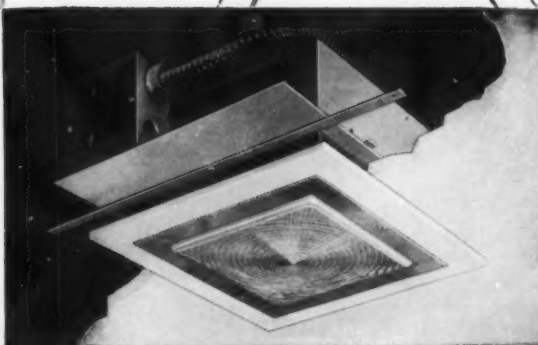
# ART METAL

makes your wiring

**EASIER** *and* **FASTER**



The Binary Plaster Frame of Art Metal units has complete installation equipment including attached junction box, wire, Greenfield and two mounting rails.



Complete specifications on Art Metal pre-wired plaster frame and lens boxes are found in Bulletin 254. We suggest you write for this bulletin . . . it'll show you how to save installation time and money on your next job!

Art Metal recessed lens box housings are easily installed as the job nears completion. Vertical slotted mounting holes provide adjustment for ceiling thickness from  $\frac{1}{2}$ " to 2".

THE **ART METAL** COMPANY

CLEVELAND 3, OHIO



# Tiger Brand ELECTRICAL WIRE & CABLE

## TIGER BRAND VARNISHED CAMBRIC



The great "in between" insulation. Varnished cambric resists moisture better than paper, and it resists heat better than rubber. When carefully selected, varnished cambric can be used as an all-purpose insulation to replace either paper or rubber when it is important to keep inventories low.

Code designation "V." Temperature rated at 85°C.

Available in a full range of sizes with cotton or asbestos braid, lead sheaths, interlocking armor or thermoplastic jackets. Single or multiple conductor. Many other constructions can be furnished.

## TIGER BRAND AMERBESTOS

American Steel & Wire offers a full range of heat-resistant asbestos-insulated wire and cable. The asbestos is *not* wrapped around the conductor. Rather, all Amerbestos uses felted asbestos which is packed over the conductor to give an insulation that will not break open when the wire or cable is bent.

### FOLLOWING TYPES ARE AVAILABLE:

- A**—plain asbestos
- AA**—asbestos with asbestos braid
- AI**—impregnated asbestos *without* asbestos braid

**AIA**—impregnated asbestos *with* asbestos braid

**AVA**—asbestos with varnished cambric

**AVL**—asbestos with varnished cambric and lead sheath

**AVB**—asbestos with varnished cambric and cotton braid

Many constructions and sizes can be supplied, such as special wires and cables for rheostats, stoves, switchboards, mining equipment, electrical fixtures—as well as a wide range of heavy-duty, high voltage power cables.



# Tiger Brand

## TIGER BRAND PAPER CABLE

For high voltage feeders. Tiger Brand Paper Cable is available in solid or gas pressure types. Insulation is carefully heated under vacuum before impregnating to remove every trace of moisture.

Lead sheaths are applied under high pressure to insure dense, homogeneous surface. Lead melting tanks

are kept in inert atmosphere to prevent formation of impurities. Arsenical or copper-bearing lead alloys can be furnished for sheaths. The former has more resistance to bursting, bending and vibration, but it is more expensive and difficult to pull than standard lead sheaths.

Many special constructions are available as standard production. Sheaths can be covered with a range of protective materials, such as metallic armor, jute, duck tapes or reinforced rubber.

**NEW.** For corrosive locations, Tiger Brand Paper Cables available with type GN jacket (heavy neoprene, reinforced with glass and fabric).



## TIGER BRAND ELEVATOR CABLE

American Steel & Wire is one of the largest manufacturers of elevator cable. Flexibility is designed into the cable so it will bend easily at the bottom of the shaft, yet not have so sharp a loop that wires will be deformed.

### FOLLOWING TYPES ARE STANDARD:

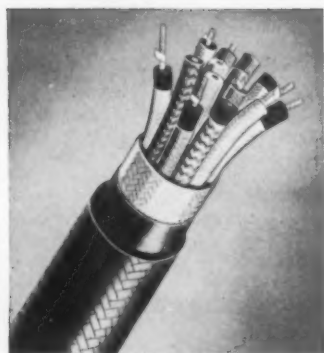
- Type E**—rubber and cotton  
—for general use.
- Type EO**—neoprene jacket  
—for hazardous locations.

**Type ET**—thermoplastic and rayon  
—fire retardant, for general use.

*All 3 types are available with steel supporting fillers if desired.*

*Type ET combines maximum fire protection and small diameter (latter due to thinner insulation).*

American Steel & Wire can also furnish a complete line of Tiger Brand annunciator cable, lighting cable, signal cable and hatch wire for use in and around elevator shafts.



## TIGER BRAND TYPE RR CABLE

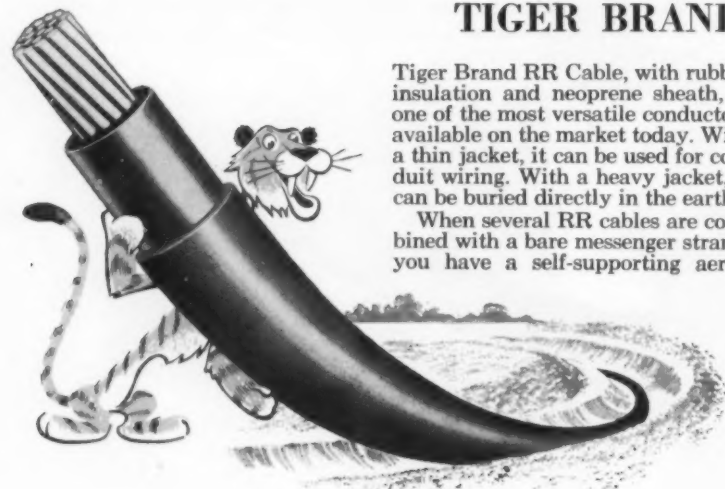
Tiger Brand RR Cable, with rubber insulation and neoprene sheath, is one of the most versatile conductors available on the market today. With a thin jacket, it can be used for conduit wiring. With a heavy jacket, it can be buried directly in the earth.

When several RR cables are combined with a bare messenger strand, you have a self-supporting aerial

cable for service drops and power feeders.

Many different rubber insulations are available to meet your special problems. Amerine type RWS is recommended for low voltage applications. For high voltages and ozone resistance, Amerzone type O (oil base rubber) is often indicated. Amerzone type B (butyl rubber) is the newest type. Since it is moisture and ozone resistant, it is often used to replace type RWS or type O.

Other compounds are available. We'll be glad to make a recommendation if you outline your specific problem.



## ELECTRICAL WIRE AND CABLE

### TIGER BRAND BUILDING WIRE

It is not possible to list the many different Tiger Brand building wires and cables available. The following are a representative group:

#### SERVICE DROP CABLE

Different constructions are available in three basic styles:

1. Self-supporting types
2. Imbedded neutral types
3. Flat tape neutral type

#### SERVICE ENTRANCE CABLE

Standard construction is the SE type U, consisting of 2 rubber conductors with concentric neutral plus tape and braid. Gray paint finish.



### INTERIOR WIRES

Type	Temp. rating	Construction
R	60°C.	rubber insulation, moisture and flame retardant braid
RH	75°C.	heat-resistant rubber and flame retardant braid
RW	60°C.	moisture-resistant rubber and flame retardant braid
RHRW	60°C. wet 75°C. dry	moisture and heat-resistant rubber and flame retardant braid
RHW	75°C. wet or dry	moisture and heat-resistant rubber and flame retardant braid
T	60°C.	thermoplastic
TW	60°C.	moisture-resistant thermoplastic
TA	90°C.	thermoplastic and asbestos with flame retardant cotton braid (for switchboard wiring only)

*Above wires and cable can be furnished with aluminum conductors if desired. Jackets can be flame retardant cotton braid or lead sheath with rubber.*

### TIGER BRAND AMERCLAD

Amerclad is our term for a complete line of *heavy-duty* portable cords and cables. The jackets for *all* cords and cables are vulcanized in a lead sheath to insure dense rubber and concentric conductors.

All cords and cables are permanently marked with molded identifications to facilitate future record-keeping.

The high neoprene-content jackets are extremely flexible, and have phenomenal resistance to abuse, sunlight, grease and oil or acid mine water.

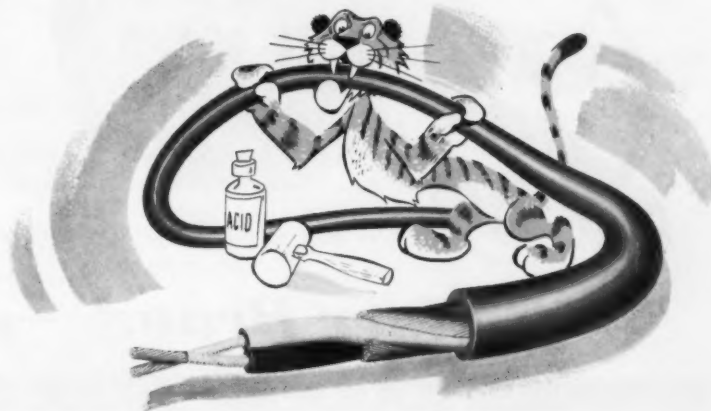
#### FOLLOWING TYPES ARE STANDARD:

**Type SO portable cords**—available with 1 through 8 conductors, conductor size from AWG 18 to AWG 10. Careful filler and jacket application make this cord highly resistant to impact or crushing.

**Type SJO portable cords**—have same construction as above type SO cords except that the jacket is lighter. Available with 2, 3 or 4 conductors, AWG 18 and 16.

**Welding cable**—has same features as above except for number of individual wires per conductor. Size AWG 1, for example, has 2107 *separate wires* to prevent kinking and relieve strain on operators' wrists. All welding cables are single conductor. Conductor size ranges from AWG 8 to 300,000 CM.

**Other Amerclad cables**—Heavy-duty multiple-conductor cables are manufactured for power shovels of any size, dredges, mining machines and comparable equipment. Voltage ratings up to 15,000 can be furnished. Conductor sizes range to 1,000,000 CM.



# Tiger Brand

ELECTRICAL WIRE & CABLE

## OTHER TIGER BRAND ELECTRICAL PRODUCTS

American Steel & Wire makes hundreds of types of electrical wire and cable not listed here. Also, special or new constructions can be specially made up to suit your needs. Some unlisted Tiger Brand products are:

**MAGNET WIRE**—with Mylar, paper, glass, Nylon or Amvar (Formvar type) insulations. Special types are available for unusual dielectric strength, abrasion resistance or heat resistance.

**ANNUNCIATOR WIRE**—for signal systems.

**MACHINE TOOL WIRE**

**ARMORED SUBMARINE CABLE**—manufactured with various protective coverings, including round wire armor. Also available in non-lead construction for light weight (an American Steel & Wire first).

**WIRE FOR OVERHEAD AND OPEN WIRE EXTENSIONS**—including weather-proof types, Neoproof (neoprene insulation) and Ampolene (polyethylene insulation).



AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO  
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS  
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



## A STANDARD TIGER BRAND CABLE FOR EVERY SPECIAL JOB

- asbestos wire and cable
- mold cured portable cord
- aerial, underground and submarine cable
- shovel & dredge cable
- paper & varnished cambric cable
- machine tool & building wire
- special purpose wire & cable

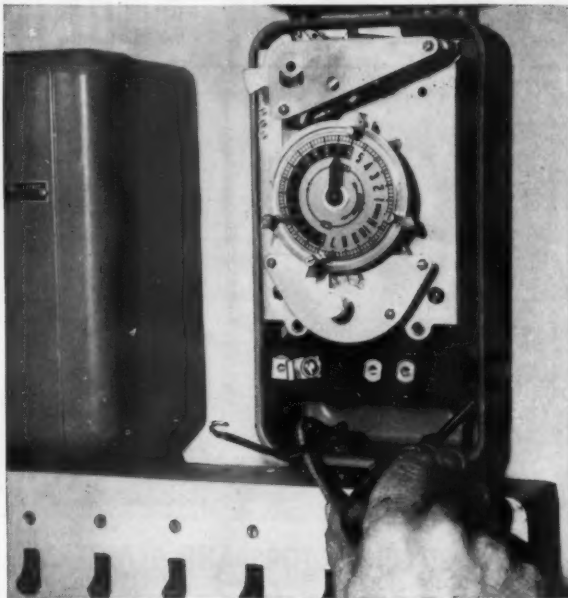
**USS Tiger Brand**

**ELECTRICAL  
WIRE & CABLE**

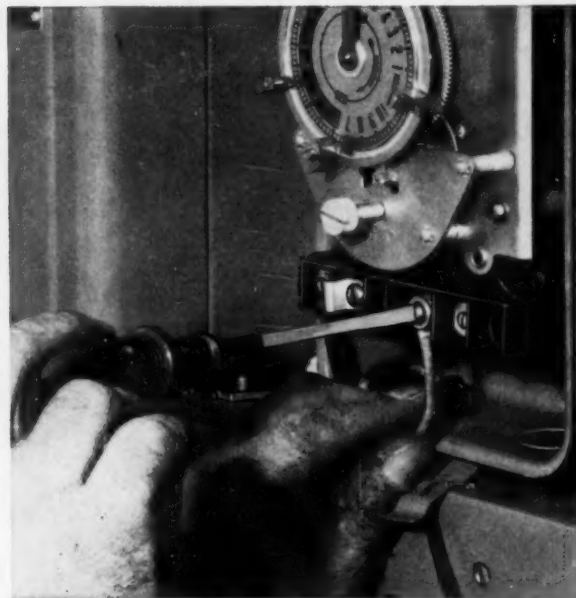


UNITED STATES STEEL



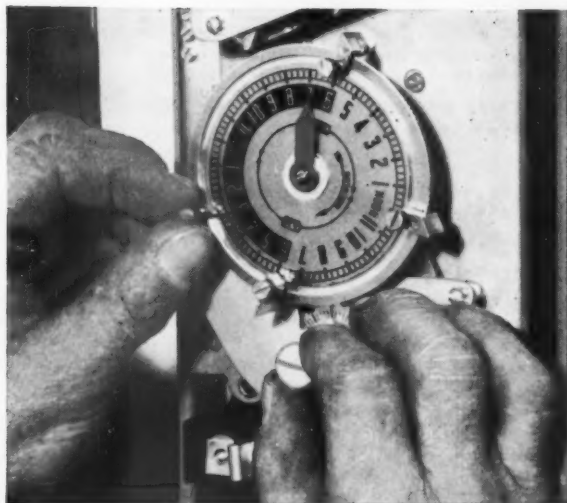


**1 ATTACH SWITCH TO MOUNTING SURFACE:** Hang by means of lug at top, secure with two screws through holes in case—takes only a few seconds; rugged, drawn-steel housing makes T-27 suitable for any outdoor-indoor installation.



**2 WIRE:** Connect to clearly marked, readily accessible terminal blocks at front of T-27—requires little time. A minimum of circuit connections, maximum hand room below terminals and five double knockouts facilitate quick wiring.

## Reduce Installation Time With Dependable General Electric Time Switches



**3 SET DIAL:** Adjust to correct time, position trippers for desired on-off period—easy as setting a wrist watch. With omitting device, T-27 skips days; with astronomic dial, follows dusk-dawn schedule; performs 10 on-off operations daily.

### 3 Simple Steps Make Installation of General Electric's T-27 Time Switch Extremely Fast and Easy

**ONCE INSTALLED** and set, the T-27 will give years of reliable, dependable on-off control.

**ACCURATE TIMEKEEPING** is assured by a self-starting, self-regulating, permanently lubricated Telechron\* motor, sealed to keep out dirt and dust.

**RUGGED CONSTRUCTION** insures little maintenance. All parts of T-27 switch mechanism subject to heavy duty are made of copper-nickel-plated steel, and switch blades are of beryllium copper for the best combination of mechanical and electrical characteristics.

**FOR MORE INFORMATION** on T-27, contact your nearest authorized G-E Time Switch distributor. Ask for G-E Time Switches at his store; and write for Bulletins GEA-5965 and GEC-535C to Section 603-168, General Electric Company, Schenectady 5, N. Y.

\*Reg. Trade-mark of General Electric Co.

**GENERAL**  **ELECTRIC**

# General Electric—one source of supply



## MAGNETIC CONTACTORS AND STARTERS

Select from a full line of open and enclosed devices—from fractional hp through 200 hp (600 volts, maximum). Available in every popular NEMA enclosure, including: general-purpose; semi-dust-tight; water-tight; dust-tight; explosion-proof; oil-immersed, corrosion-resistant; and JIC (automotive).

**COMPLETE LINE OF MODIFICATIONS** is offered on magnetic starters such as: push button or selector switch in cover, extra interlocks, third pole overload relays, separate a-c control circuit, and extra control relays.

- 1. FULL-VOLTAGE MAGNETIC STARTERS** (CR7006) for squirrel-cage induction motors are available in size 00 to size 5 with bi-metallic overload protection.
- 2. REVERSING CONTROLLER** (CR7009) combines two standard magnetic starters and mechanical interlock.
- 3. MULTI-SPEED CONTROLLER** (CR7107) is ideal for full-voltage starting of 2-, 3-, or 4-speed squirrel-cage motors.
- 4. COMBINATION STARTERS** (CR7008) provide disconnecting means and short-circuit protection by nonfusible or fusible disconnect, or circuit breaker.
- 5. CONTACTORS AND MULTI-CIRCUIT CONTROL RELAYS** (CR2810 and CR2820) will handle loads from 5 to 240 amps.

## PUSH BUTTONS, SELECTOR SWITCHES, INDICATING LIGHTS

### STANDARD-DUTY PUSH-BUTTON STATIONS

(CR2943). Stations are available with 1, 2, or 3 buttons and in pendant form. Double-break silver contacts assure reliable operation. Units are back-mounted on cover and need not be removed for wiring.

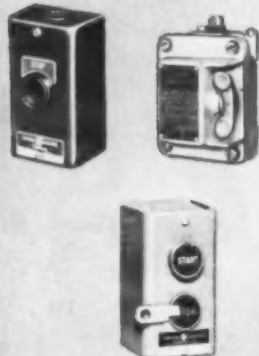
### HEAVY-DUTY PUSH-BUTTON STATIONS

(CR2940). Stations offer wide variety of 1- to 6-unit combinations of push buttons, selector switches, and indicating lights. Also furnished for flush mounting. Palm-, foot- and treadle-operated stations available.

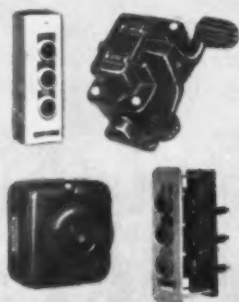
### OIL-TIGHT PUSH-BUTTON UNITS AND STATIONS

(CR2940). Units have building-block design permitting any combination of contact arrangements. Also available are indicating lights and selector switches. Enclosures accommodate 1 to 16 units.

### STANDARD DUTY



### HEAVY DUTY



### OIL-TIGHT



# for all your general-purpose control



## MANUAL AND REDUCED VOLTAGE STARTERS

- 1. FRACTIONAL HORSEPOWER MANUAL STARTERS** (CR1061) are small-size, across-the-line starters operated by toggle switch—includes accurate bi-metallic overload protection.
- 2. MANUAL STARTER UP TO 7½ HP** (CR1062) has snap-action toggle switch or push-button operator which trips free on overload. Available in 2-, 3-, or 4-pole forms.
- 3. MANUAL REDUCED-VOLTAGE STARTERS** (CR1034) are autotransformer types used where reduced starting currents or limited starting torques are needed. Undervoltage protection prevents automatic restart in event of power failure.
- 4. MAGNETIC REDUCED-VOLTAGE STARTERS** (CR7051, CR7056) are autotransformer or resistor types designed for remote or automatic reduced-voltage starting. Timing relay provides proper timing for step-starting, eliminating excessive motor inrush currents.

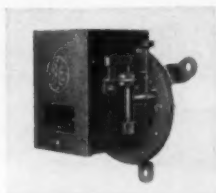


**General-Purpose Relay.** (CR2790). For control circuit applications. Small in size with extremely long life. Rated 10 amps continuous (left).

**Solenoids** (CR9500). New strongbox solenoid provides firmly anchored terminal and lead type connections in a single unit. 22% smaller units mount five different ways. Complete rating coverage in push and pull, 24 to 600 volts, 25 to 60 cycles and d-c (right).



**Plugging Switch** (CR2962). A pilot circuit device used in conjunction with reversing magnetic starter to automatically apply and remove plugging power for quick stopping of a motor.



**Pressure Switches** (CR2927). A pilot device used to handle small motors directly or in conjunction with a magnetic starter for starting and stopping pressure generating equipment.



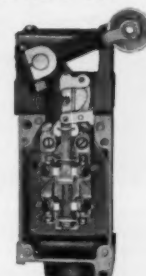
**Float Switches** (CR2931). Used in conjunction with a magnetic starter to start and stop small a-c and d-c motors. Float and counterweight may be interchanged for tank or sump operation.

## LIMIT SWITCHES

### LEVER OR ROTATING TYPE

#### Double Circuit Lever Type

(CR9440D). Snap action contacts can be changed from normally open to normally closed or vice versa. In open or oil-proof enclosed forms.



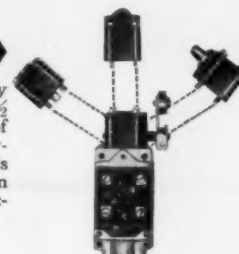
#### Snap-Action Lever Type

(CR9440J). Used for heavy make-and-break requirements. Forms are available adjustable through 360 degrees. Operating lever firmly attached to shaft by double set of splines



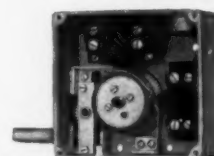
#### Small Snap-Action Oil-Tight

(CR9440K). Only 1½ and 1¼ by 4¼ inches. Oil-proof switch has 4 interchangeable heads that can face in any of four directions.



#### Rotating Cam Type

(CR9441E) Two snap-action contact units operated through a worm gear reduction. Operating cams are easily set by adjusting only two screws.



### COMPLETELY NEW CATALOG OF G-E GENERAL-PURPOSE CONTROL

Advertising and Sales Promotion Section M734-1  
General Purpose Control Dept.  
General Electric Company  
Bloomington, Illinois

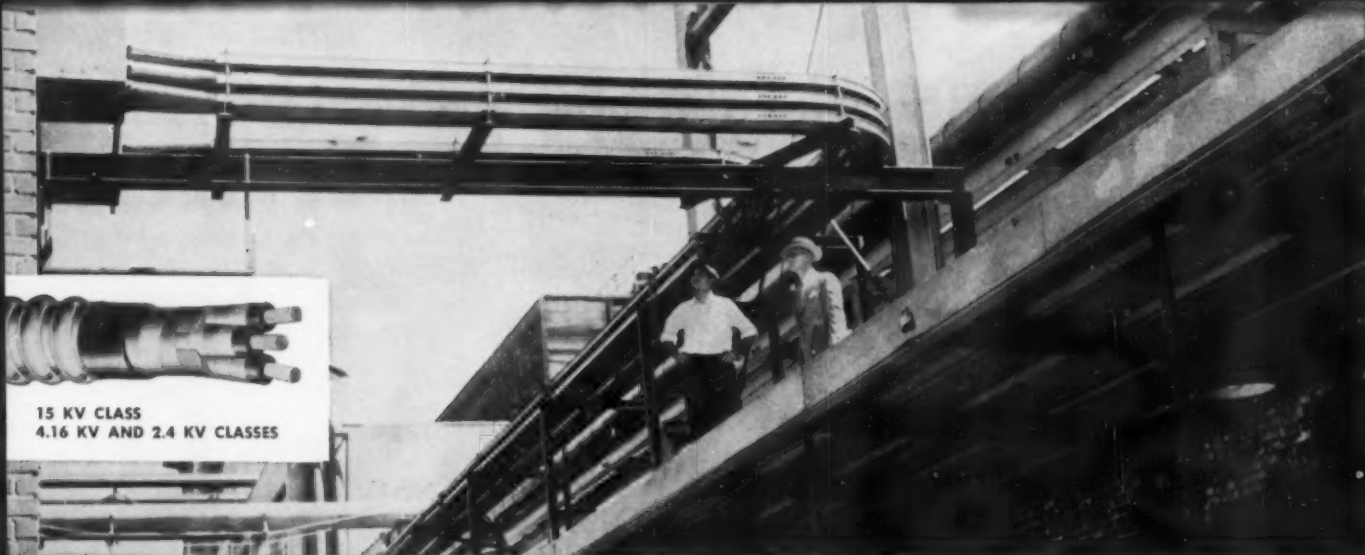
Please rush me a free copy of the new general-purpose control catalog, GEC.

Name .....  
Title .....  
Company .....  
Address .....  
City ..... State .....

For more information on any of these general-purpose controls, contact your nearest G-E Apparatus Sales Office, or distributor.

# GENERAL ELECTRIC

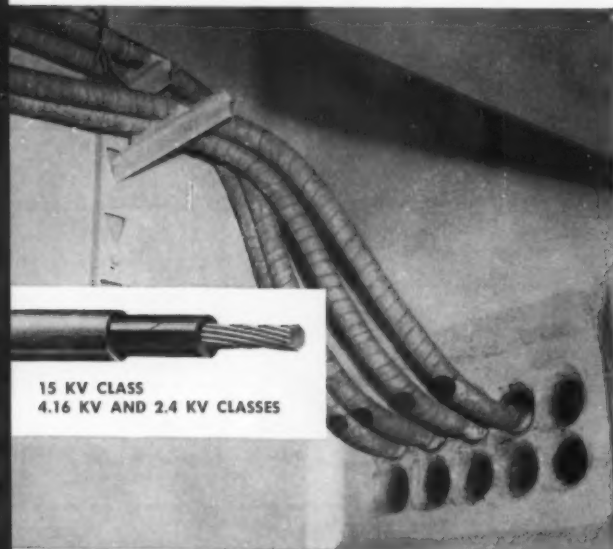




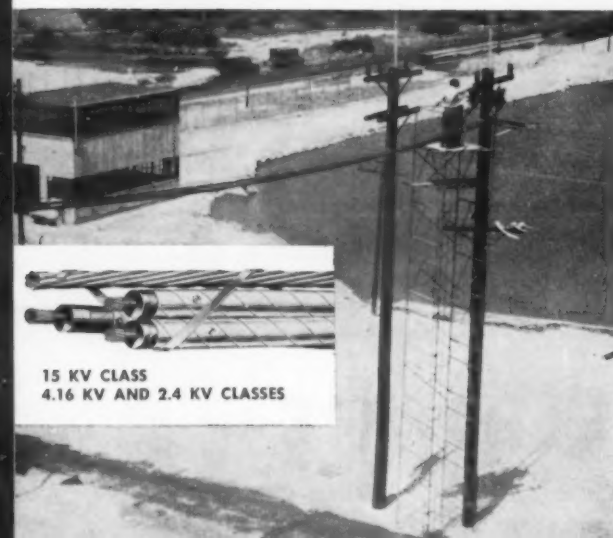
15 KV CLASS  
4.16 KV AND 2.4 KV CLASSES

**▲ G-E INTERLOCKED ARMOR CABLE** For use above ground. Both indoor and outdoor runs. Cable runs along elevated pipe structure. Supported by racks, trays, or messengers.

**▼ G-E VARNISHED CAMBRIC LEADED CABLE** For conventional underground installation. High impulse strength for voltage surges. The lead sheath is impervious to moisture.



15 KV CLASS  
4.16 KV AND 2.4 KV CLASSES



15 KV CLASS  
4.16 KV AND 2.4 KV CLASSES



4.16 KV AND 2.4 KV CLASSES  
600 V CLASS



**G-E SILICONE RUBBER CABLE** For use where high ambient temperatures, high humidity, corrosive vapors and other severe operating conditions exist. Extra reliability in case of nearby fire.



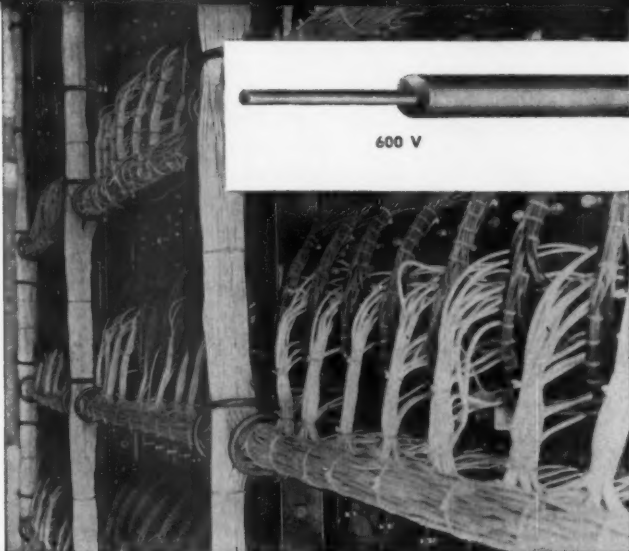
15 KV CLASS  
4.16 KV AND 2.4 KV CLASSES



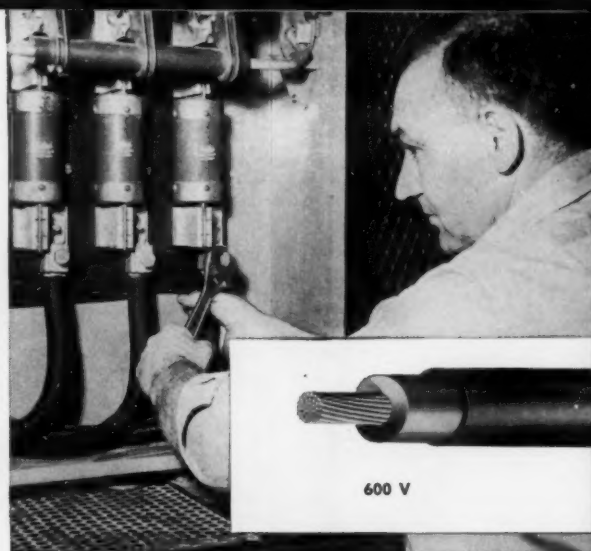
**G-E SUPER CORONOL® GEOPRENE® CABLE** For underground use. Duct, conduit, and raceway installations, or burying cable directly in the ground. Resists oxidation, ozone, corona, sunshine, water, etc.

**G-E PREASSEMBLED AERIAL CABLE** Mostly for outdoor runs. Long spans, supported by poles, towers, or buildings.





**G-E FLAMENOL\* CABLE** The ultimate in chemical resistance above or below ground level. Single conductors in ducts, raceways, conduit, or buried.



**G-E VERSATOL\* GEOPRENE CABLE** For cables above or below ground level. Large conductors, heavy loads. Resists moisture and chemicals. Flexible—an all-purpose cable.

## TO MEET YOUR NEEDS FOR INCREASED POWER

Select a G-E cable  
to meet your requirements

Since reliable power supply is a vital factor in any industry, you'll be interested in high-quality cable of the right type for your application. Specify General Electric cable to meet your needs.

**POWER CABLES** for special or general purpose; for feeder systems, distribution systems, equipment leads and railway, shipboard, and mining applications.

**CONTROL CABLES** for aircraft wiring, station and communications systems, and appliance and equipment wiring.

**For other industrial applications,  
specify General Electric Cords and Wires**

**G-E CORDS** are available for practically every type of electrical appliance or industrial equipment.

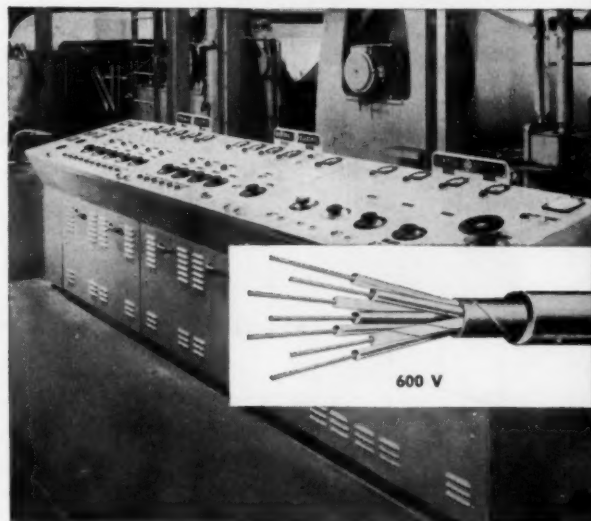
**G-E MAGNET WIRE** can be furnished to meet every requirement of industry for long-lived and dependable electrical apparatus.

To meet your power requirements, select a General Electric cable, wire, or cord. Write Section W157-518, Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

\*Registered Trade-mark General Electric Company

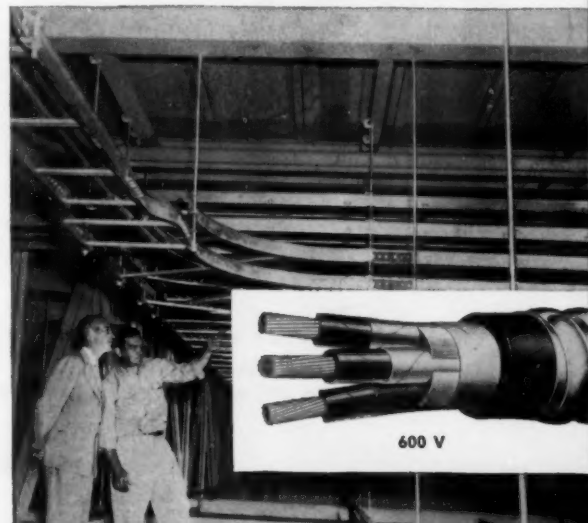
*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**



**G-E FLAMENOL CONTROL CABLE** For important control circuits, switchboard leads, and motor leads. Can be installed in open air, in ducts, or in conduit.

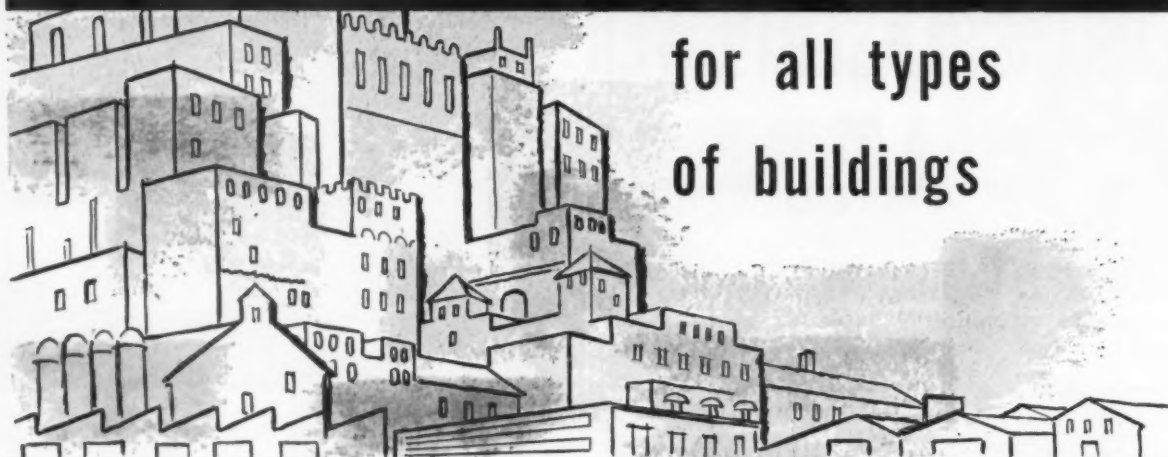
**G-E VARNISHED-CAMBRIC FLAMENOL INTERLOCKED ARMOR CABLE** For installation above ground. Indoor and outdoor exposures. Resists mechanical abuse.





means safe,  
dependable

## POWER and LIGHT CONTROL



for all types  
of buildings

### TYPICAL PRODUCTS



SHUTBRACK  
SWITCHBOARD



SHUTBRACK SWITCH



MAIN & RANGE



MIDGET POWERPLUGIN



POWERPLUGIN



HIGH EFFICIENCY  
BUSDUCT

*Frank Adam Electric Co.*

Phone JEFFerson 3-6550  
BOX 357, MAIN P. O. • ST. LOUIS 3, MO.

makers of:  
busduct • panelboards • switchboards  
service equipment • safety switches  
load centers • Quikmeter

For more than 64 years, the trade mark **FA** has been a symbol of quality in the manufacture of electrical products for the control and distribution of power and light for all types of buildings, ranging from the smallest residence to the largest commercial, industrial or institutional structure — products that are modern in design, rugged in construction, and will provide safe, dependable, long-lasting and trouble-free service.

If you want to assure customers power and light control geared to the demands of today and tomorrow, then insist on installing **FA** products.

And, should you want additional information on any or all **FA**

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Baltimore 2, Md.	J. L. Howarth Co. Inc., 3021 Seventh Ave. South	53-1711
Birmingham, Ala.	Herbert Madden Co., Inc., 17-23 Phipps St.	Charleston 2-3630
Boston 29, Mass.	Hunter & Bell Co., 858 Main St.	Elmwood 2210
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Miami 47, Fla.	Gordon F. Stoffer & Bros., 707 E. St. Clair Ave.	Superior 1-3535
Cleveland 14, Ohio	Gordon F. Stoffer & Bros., 101 N. High St.	Capitol 1-4403
Columbus 4, Ohio	P. A. Michler, 2807 Allen Street	Prospect 0108
Dallas 1, Tex.	F. E. Staible & Sons, 2046 Arapahoe St.	TABor 5-3991
Denver 2, Colo.	Midwest Equipment Co., 842 Fifth Ave.	3-1203
Des Moines 14, Ia.	Midwest Equipment Co., 736 Federal St.	7-4074
Davenport, Ia.	J. P. Laughlin, 10330 Puritan Ave.	UNiversity 4-6425
Detroit 27, Mich.	B. L. Winkler, 776a M. & M. Bldg.	Fairfax 6225
Houston 2, Tex.	Harry L. Dickinson, 404 Merchants Bank Bldg.	FRanklin 3688
Indianapolis 4, Ind.	B. L. McCreary & Son, 1819 Central St.	Harrison 1668
Kansas City 8, Mo.	N. B. Nichols, Rm. 209, Terminal Warehouse	Franklin 4-6797
Little Rock, Ark.		

## EXPERT COUNSEL

from these



## REPRESENTATIVES

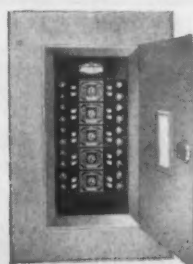
products consult your nearest **FA** representative listed on this page.

These men are specialists in power and light control and distribution. They will be delighted to provide expert counsel and advice on all power and light control problems, furnish latest engineering data on the **FA** products shown on this page, as well as others, and assist you in any way they can, consistent with good ethics and practice. So don't hesitate to call on them, or write for Bulletins.

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New York 19, N. Y.	Fred G. Kraut & Son, 419 W. 54th St.	Columbus 5-6861
Oklahoma City 6, Okla.	Ray Sullens, 1941 N. W. 17th St.	JACKson 8-2979
Omaha 2, Neb.	Midwest Equipment Co., 1614 Izard St.	ATLantic 7600
Philadelphia 3, Pa.	Paul F. Kyack, 10 S. 18th St.	RITTEnhouse 6-9024 6-8328
Pittsburgh 22, Pa.	J. R. Schmidt, 200 Magee Bldg.	ATLantic 1-5402
Richmond 26, Va.	W. E. Sullivan, Jr., 6211-A West Broad Str. Road	88-620
St. Louis 6, Mo.	O. H. Rottmann, 1023 N. Grand Blvd.	JEfferson 3-7100
San Francisco 5, Cal.	Columbia Electric Mfg. Co., 275 Steuart St.	GARfield 1-6101
Seattle 9, Wash.	Standard Electric Sales, 550 Mercer St., Suite 101	ALder 5999
Spokane 1, Wash.	W. A. Crowder, 1011 East Empire Ave.	MADison 2244
Syracuse 10, N. Y.	F. L. Grant, 625 Cumberland Ave.	72-1831
Tulsa 5, Okla.	Elmer W. Luebbert, 1203 E. 31st St.	72-8684

### EXPORT REPRESENTATIVE

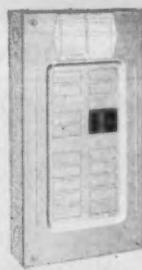
St. Louis 7, Mo.	T. G. Rogers, 5411 Bulwer Ave., (P. O. Box 59, Baden Station)	EVergreen 1-3700
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LNTF PANELBOARD



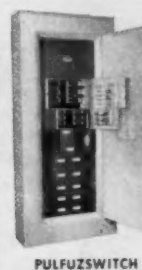
QP DUSTITE  
PANELBOARD



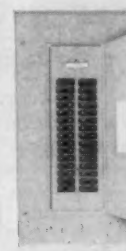
SPLIT-BUS  
SERVICE  
EQUIPMENT



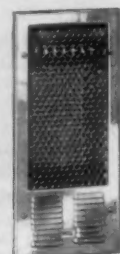
T-M LOADCENTER



PULFUZSWITCH  
PANELBOARD



QP QUICKLAG P  
PANELBOARD



QUICKMETER

. . . another advance in mercury lighting from G. E.

# Now 54% more light from G-E 400-watt mercury lamp

## New General Electric H400-RC1 gives top color balance, too

In another mercury lighting first, General Electric has raised the light output of the H400-RC1 mercury lamp from 12,300 to 19,000 lumens! This 54% increase in efficiency results from using a special fluorescent phosphor as a reflector as well as to improve color balance. Its color characteristics are best of any mercury lamp for general lighting. Color rendition approximates a mixture of  $\frac{1}{2}$  filament light and  $\frac{1}{2}$  mercury light.

The new G-E H400-RC1 mercury lamp has a life rating of 6000 hours at 5 or more hours per start. It operates on the same equipment as all other 400-watt mercury lamps and is interchangeable in most reflectors.

With its controlled beam, good color, easy maintenance, and high light output, it is first choice for most mercury lighting applications.

For more information on how this new mercury lamp can fit your operation, call your G-E Lamp supplier, or write General Electric Company, Lamp Division, Dept. 482-ECM-5, Nela Park, Cleveland 12, Ohio.



### COMPARE NEW G-E RC1 WITH OTHER 400-WATT MERCURY TYPES

#### NEW RC1 VS H400-E1

- Light on the work equal or greater in most equipment
- Adds color balance
- Less maintenance



#### NEW RC1 VS H400-J1

- Delivers 10-20% more light on the work in most equipment
- Has somewhat better color balance
- Lower cost of light



#### NEW RC1 VS H400-A1

- 35% more light on the work in most equipment
- Has good color balance
- Lower cost of light



*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

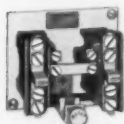




**1** Manual Disconnect with cabinet door handle safety interlock.



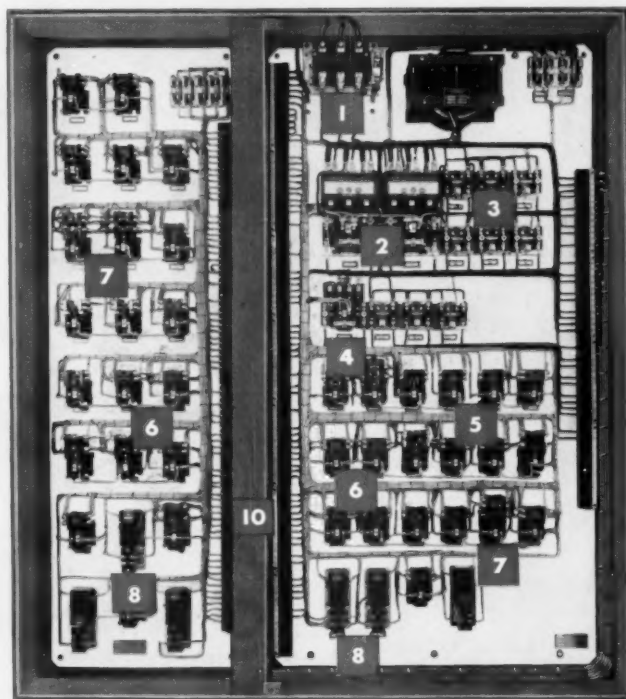
**2** Large Solenoid Starter with overload relays.



**3** Overload Relays



**11** Master Station



**10** Automatic Control Panel for Hoern & Dilts boring machine shown below.



**9** Oiltight Push Buttons

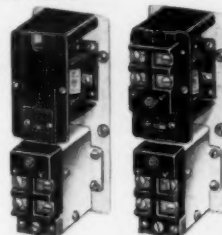
With mushroom head push button and oiltight diaphragm for oily locations.



With selector for 3-way Automatic-Off-Hand control.

**8** Pneumatic Timers

Easily adjustable from 1/6 second to 3 minutes. Available in a large variety of On-Delay or Off-Delay contact combinations. Also listed for direct current.



**4** Small Size 1 Solenoid Starter



Complete line includes 8 sizes—from Sizes 0 to 7.

**5** Four-pole Relay



In any combination of normally open or normally closed contacts.

**6** Universal Relay



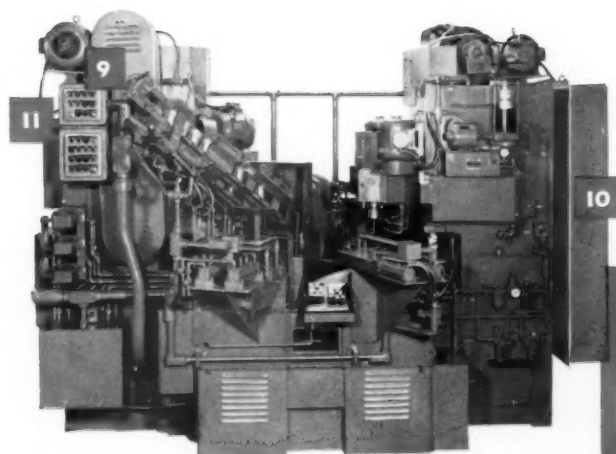
Has normally open and normally closed contacts. Merely change connections.

**7** Eight-pole Relay



8-Pole relay with 4 N.O. contacts.

## HOW TO BUILD TROUBLE-FREE MOTOR CONTROL PANELS



Hoern & Dilts Model BH-16-35 Indexing Type Precision Turning and Boring Machine equipped with A-B controls and oiltight push buttons.

Special control panels are commonly used with modern production machines. They are the "brains" of the machine—they must be dependable. Therefore, they must be assembled with trouble-free components... like the Allen-Bradley starters, relays, timers, and control stations shown on this page. The Allen-Bradley reputation for QUALITY is your assurance of trouble-free operation.

Send for the latest edition of the 120-page Allen-Bradley Handy Catalog... it's a veritable handbook of modern automatic and manual motor controls. Write, today.

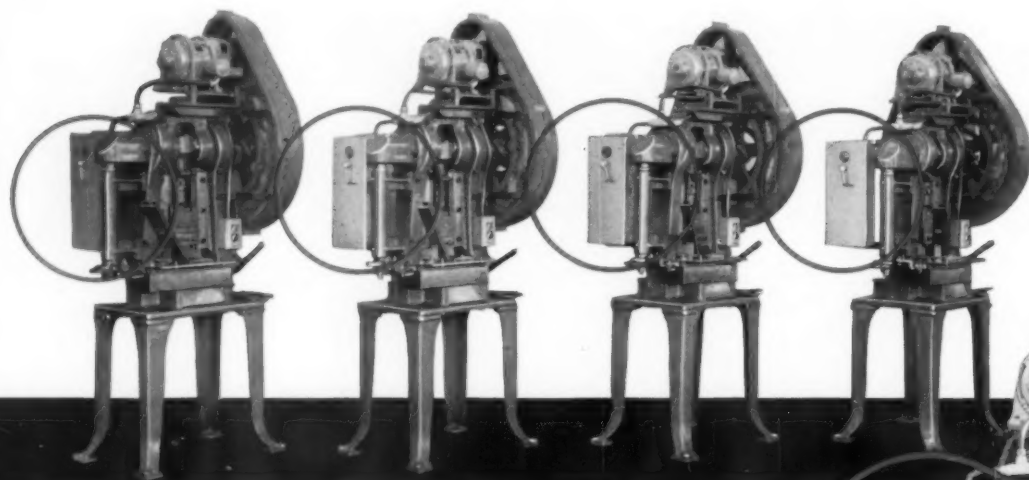
Allen-Bradley Co.  
1316 S. Second St.  
Milwaukee 4, Wis.

In Canada—  
Allen-Bradley Canada Ltd.  
Galt, Ontario



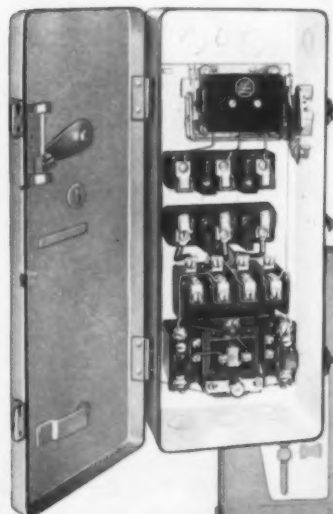
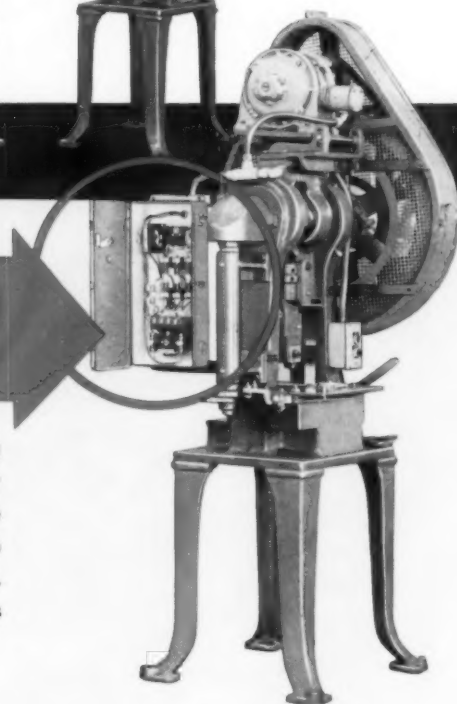
**ALLEN-BRADLEY**  
QUALITY  
**MOTOR CONTROL**

Waterbury Farrel  
Stamping Presses  
equipped with A-B  
Combination Starters.



**DISCONNECT SWITCH—FUSES—SOLENOID STARTER**  
... all combined in **ONE ENCLOSURE** ...

Alert machinery manufacturers recognize the sales advantage of equipping their motor-driven machines with these compact combination starters. They combine disconnect switch, fuses, and solenoid starter in a single enclosure ... and they provide this added safety feature ... it is impossible to open the starter cabinet until the disconnect lever is moved into the OFF position. The combination starter provides a clean, finished appearance—a sales asset for any machine tool. And—the installation cost is less!



Bulletin 712  
Combination Starter  
with  
Manual Disconnect  
Switch and Fuses

Bulletin 713  
Combination Starter  
with  
I-T-E  
Circuit Breaker

*Standardize* on **A-B COMBINATION STARTERS**  
... for **Compact and Safe Motor Control**

Allen-Bradley combination starters come in two general types—Bulletin 712 with a manually operated disconnect unit (with or without fuse clips)—and Bulletin 713 with an I-T-E instantaneous circuit breaker.

See the neat, compact starter installations on the machines, above. Streamline your machines to give them a "New Look" with Allen-Bradley combination starters. Write, today, for the A-B 120-page Handy Catalog.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

In Canada—Allen-Bradley Canada Limited, Galt, Ont.



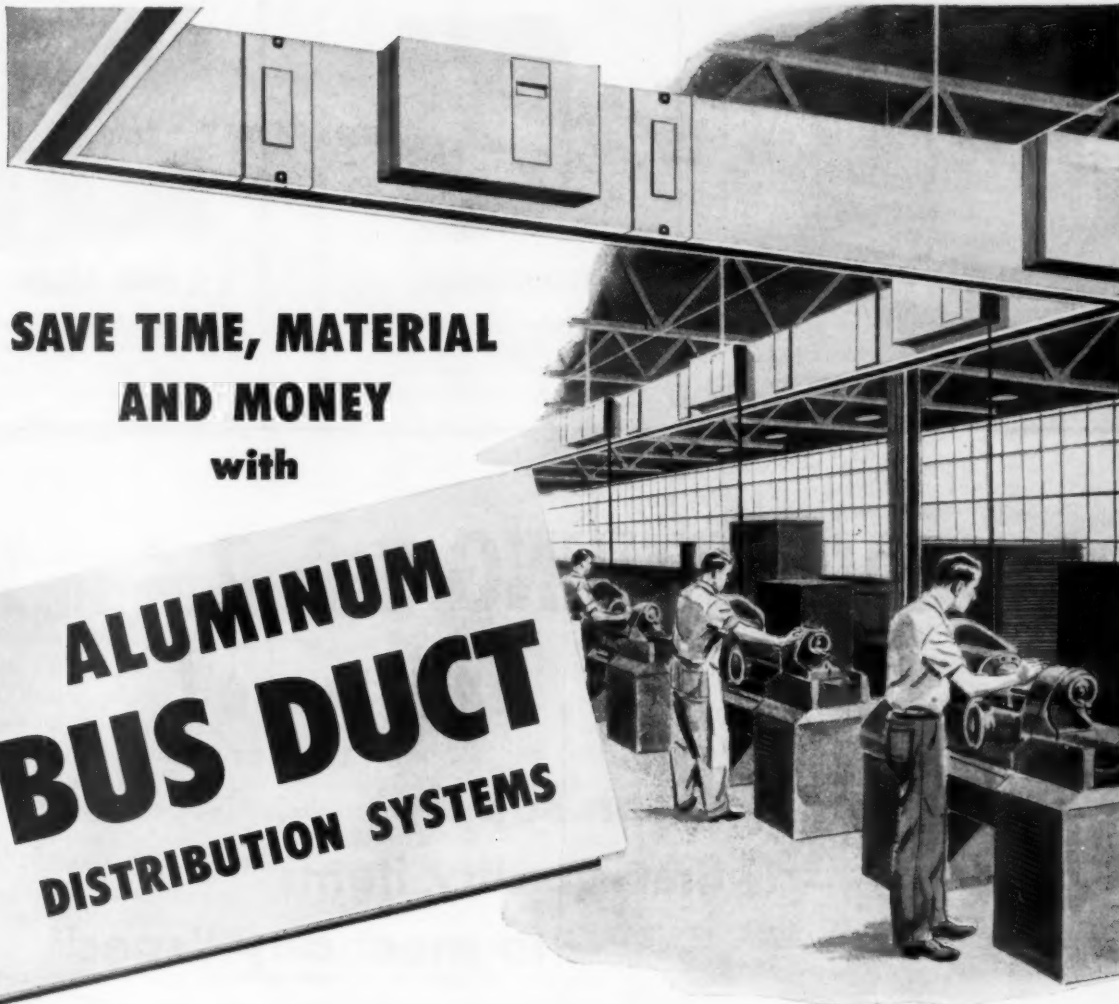
**ALLEN-BRADLEY**

BULLETIN

QUALITY

712-713

**COMBINATION STARTERS**



**SAVE TIME, MATERIAL  
AND MONEY  
with**

# **ALUMINUM BUS DUCT DISTRIBUTION SYSTEMS**

The flexibility of bus duct electrical distribution systems is practically unlimited. They are easily adaptable to both horizontal or vertical layouts for industrial, office and commercial buildings—for small buildings or large, for one-story spreads or skyscrapers.

In industrial plants, bus duct systems minimize downtime for machinery relocations because outlets are always at hand and circuit changes are made quickly and easily. Wire waste is kept to a minimum thus reducing costs. Bus duct is also practically 100% salvageable—can be removed from existing installations and used elsewhere without appreciable loss of material. Plant expansion is more economical, too, because prefabricated duct sections can be extended swiftly, with minimum service downtime and at a lower installed cost than cable and conduit or wireway.

## **NEW RABC\* OFFERS IMPORTANT ADVANTAGES IN BUS DUCT DISTRIBUTION SYSTEMS**

Just as bus duct distribution is the most economical method, new RABC is also the most economical conductor material. The basic advantages of RABC include more conductivity

per dollar; long range availability; light weight which permits faster, lower cost installation—requires less time, less equipment and fewer men to install. New RABC also provides greater strength than other aluminum conductors with very little effect on electrical conductivity. And because RABC is available in an unlimited range of sizes and shapes, it is no longer necessary to use oversize conductor because of intermediate size limitations.

Reynolds does not make bus duct distribution systems, but we would like to send you more information about their advantages. Just return the coupon below.

Reynolds Metals Company, P.O. Box 1800-ET, Louisville 1, Ky.

Please send literature on aluminum conductor in Bus Duct Distribution Systems. ☐ Also send names of system manufacturer.

Company \_\_\_\_\_

Name \_\_\_\_\_ Title \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

\*Reynolds Aluminum Bus Conductor

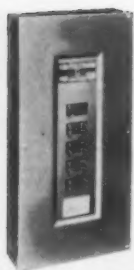
# **REYNOLDS**



# **ALUMINUM**

**MODERN DESIGN HAS ALUMINUM IN MIND**

ELECTRICAL CONSTRUCTION AND MAINTENANCE . . . MAY, 1955



## 2.4 SERVICE ENTRANCE EQUIPMENT

Busduct . . . service-entrance switch panels . . . meters . . . grounding devices



## 3.0 TRANSFORMERS

Transformers . . . substations . . . switch gear . . . inductrols . . . capacitors . . . meters . . . testing equipment



## 4.2 PANEL BOARDS

Panel boards . . . switch boards . . . circuit breakers . . . fuses . . . pull boxes . . . instruments

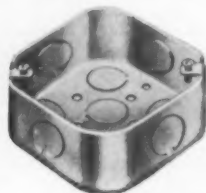
# EVERYTHING from 2.4 to 11.1 ... and more!

**Graybar can supply  
first-quality items  
to meet any "spec"**

**CALL GRAYBAR FIRST FOR...**

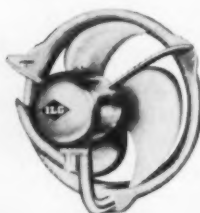


IN OVER 120 PRINCIPAL CITIES



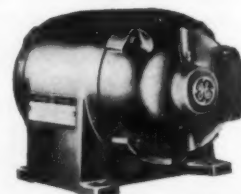
## 11.1 RESIDENTIAL WIRING

ABC nonmetallic sheathed cables . . . wiring devices . . . receptacles . . . boxes . . . fittings



## 10.1 HEATING, VENTILATING AND AIR CONDITIONING

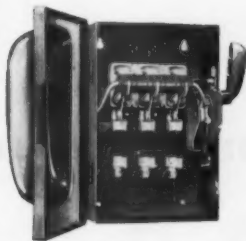
heating panels . . . electric heaters . . . fans . . . ventilators . . . air conditioning units



## 9.1 MOTOR AND CONTROL

Fractional-hp. and integral-hp. AC and DC motors . . . controls . . . starters and panels





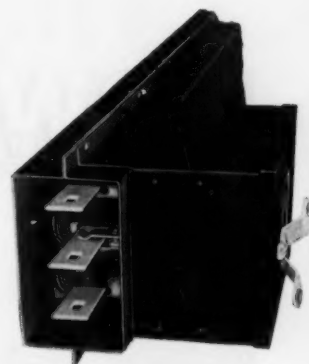
#### 4.4 SWITCHES

Protective devices . . . fuse cutouts . . . switches



#### 5.0 FEEDERS

Bus feeder . . . conduit . . . cable . . . fittings . . . boxes . . . wire



#### 5.8 BUS DUCT

Enclosed bus bar distribution systems . . . bus drop cable . . . trolley duct . . . control centers

Whatever your "specs" call for, Graybar can supply — as fast as any source, and often faster — the right apparatus, equipment, and materials to meet them . . . plus all the specialized tools you need.

Electrical contractors everywhere choose Graybar because (1) we distribute the widest selection of first-quality products of leading manufacturers; (2) our nationwide warehousing system speeds delivery; (3) our specialists in inside construction, outside construction, lighting, signaling and power apparatus are helpful in selecting and applying the best items for specific jobs; (4) one order, one responsibility means less handling, less paperwork and better inventory control.

Discover for yourself the real meaning of "Graybar service." At every Graybar office you can always expect the extra bit of service that's provided by people eager to please, for Graybar is solely-owned by its operating and retired personnel.

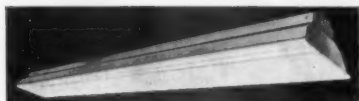
*Graybar Electric Company, Executive offices:  
Graybar Bldg., New York 17, N. Y.*

512-45



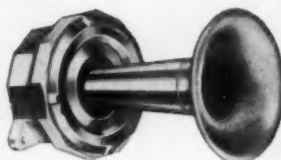
#### 5.9 UNDERGROUND

Fibre conduit . . . steel conduit . . . low- and high-voltage cables . . . tools . . . pot heads



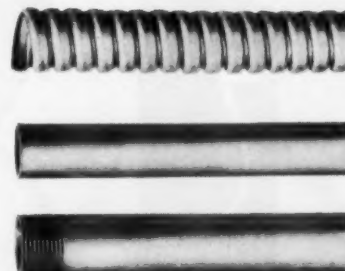
#### 8.1 LIGHTING

The most complete selection of lamps and lighting units available from any single source



#### 7.1 SIGNAL, COMMUNICATIONS & AUXILIARY SYSTEMS

Every type of signaling system for office, factory or institution



#### 6.1 BRANCH CIRCUIT

Circuit wire . . . conduit . . . fittings . . . special raceway systems . . . boxes . . . low voltage switches . . . EMT . . . armored cable

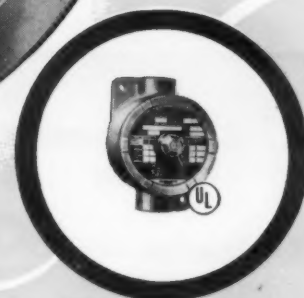
# NOW

## ... complete, explosion-proof lighting



**Type EVA Explosion-Proof  
Lighting Fixture**  
200-Watt, with or without  
guard or reflector.  
Overall length: 13-3/16"

**NO AIR PRESSURE NEEDED!** Since Type EVA contains the explosion rather than preventing it, no "pumping up" is required. Nor is there any pressure switch to fail and possibly create a hazardous condition. Also, fixture need not be removed from the hazardous area to re-lamp. Merely switch off the circuit — unscrew globe holder — replace lamp. Less maintenance, *easier* maintenance and much lower initial cost are plus features of this new explosion-proof Crouse-Hinds Lighting Fixture.



**Type FSPC Explosion-Proof  
Tumbler Switch Condulets**  
in 1, 2, 3-pole; 3 and 4-wire;  
DP DT (no "off") styles.

installations for acetylene and hydrogen areas!

# CROUSE-HINDS

## CONDULETS®

**UL-Approved for Class 1, Groups A & B Locations**

From switch to lighting fixture, Crouse-Hinds' is the first complete lighting system designed and UL-approved for Class 1, Groups A & B hazardous locations.

These explosion-proof fixtures and Condulets are entirely new — provide greater installation flexibility. Fixtures may be re-lamped — *even in the presence of combustible gases* — since gas-tightness is *not* a requirement for their safe performance. And they are safe . . . their heavier, more shock-resistant construction withstands the pressure of internal explosions without rupturing . . . their flame-tight joints prevent the escape of flames to flammable atmospheres.

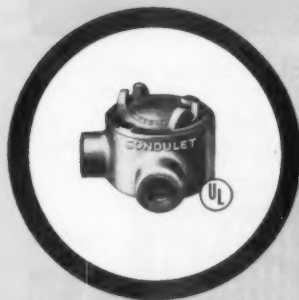
\* Whether you're installing a complete explosion-proof lighting system — or merely converting a few of your Group C or D fixtures to these safer Group A's — your Crouse-Hinds Distributor can be a definite help. See him. Or write us.



## CROUSE-HINDS COMPANY

SYRACUSE 1, N. Y.

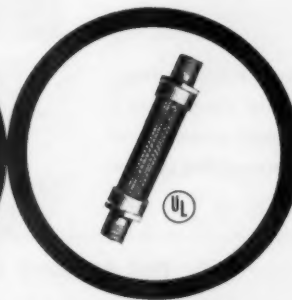
OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Memphis — Milwaukee — New Orleans — New York — Philadelphia — Pittsburgh — Portland, Ore. — St. Louis — St. Paul — San Francisco — Seattle — Toledo — Washington — RESIDENT REPRESENTATIVES: Albany — Atlanta — Baltimore — Baton Rouge — Charlotte — Chattanooga — Corpus Christi — Reading, Pa. — Richmond, Va. — Shreveport — Crouse-Hinds Company of Canada, Ltd. — Toronto, Ont.



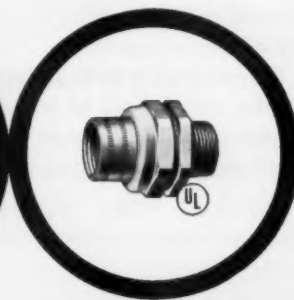
**Type EAB Explosion-Proof Junction Condulets** in ½", ¾" and 1" hub sizes—through feed, L, T and X hub arrangements.



**Type EYS Explosion-Proof Sealing Condulets** in ½", ¾" and 1" hub sizes.



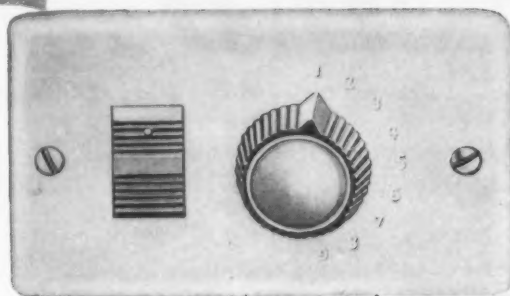
**Type EC Explosion-Proof Flexible Couplings and fixture supports** in ½" and ¾" sizes.



**Types UNY, UNL, UNF Explosion-Proof Condulet Unions** female and male styles in ½", ¾" and 1" sizes.

# NEW!

## BRYANT LOW VOLTAGE MULTI-CONTROL WIRING SYSTEM



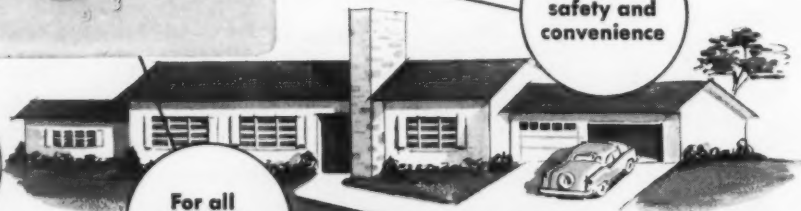
Easy,  
Economical  
Installation—

New System offers advantages of  
LOW VOLTAGE control of lighting  
and appliance circuits from con-  
veniently located points.

Added  
safety and  
convenience

New profit  
opportunities  
for you

For all  
types of  
buildings



The BRYANT MULTI-CONTROL Wiring System is the most modern method of controlling electrical circuits. Through the use of small relays, usually mounted in conventional outlet boxes, which are actuated by low voltage switches, lighting and appliance circuits may be economically controlled from one or any number of desired locations. Another outstanding feature, not available in conventional wiring systems, is the Master Switch Control. One or more master switches may be installed at strategic locations for the control of any number of circuits.

This switching system operating on low voltage, is safer and the use of less costly conductors is possible. Flexibility, versatility and economy of installation are outstanding features of this system.

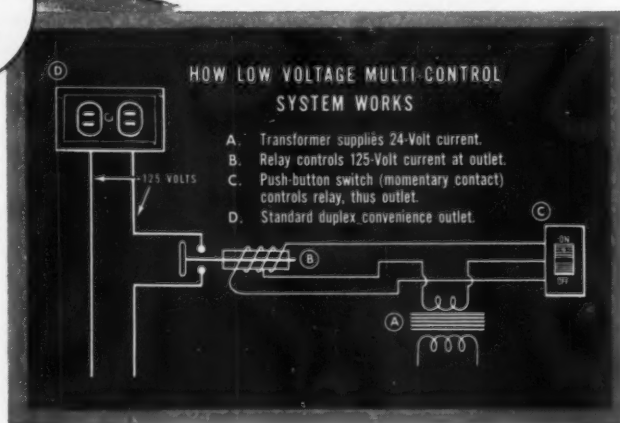


Diagram shows basic circuit of the Bryant system.

The System is easy to sell and install.  
Send for Booklet MCM-754

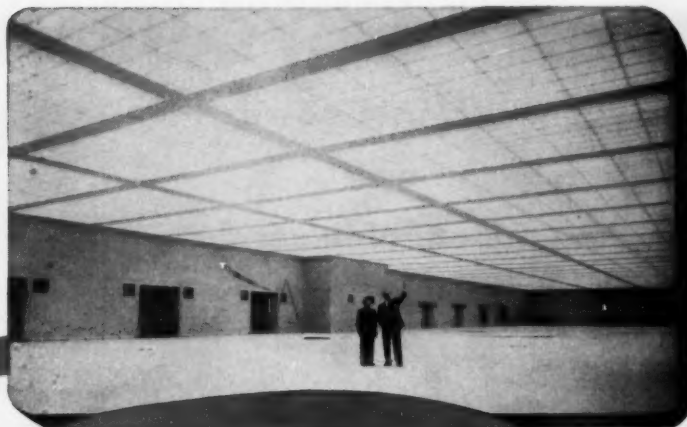
**THE BRYANT ELECTRIC COMPANY**  
Bridgeport 2, Connecticut  
Chicago • Los Angeles



J-99907A

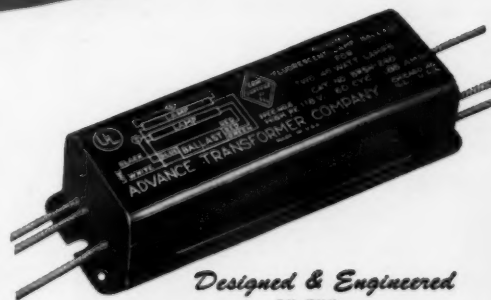


# 2 NEW ADVANCE EXCLUSIVES



## ADVANCE FLUORESCENT LAMP BALLASTS USED IN TWO FORD PLANTS

Views of the two new Ford Plants, one in the Engineering and Research Center, Dearborn, Mich. (upper picture) and the new aircraft wing plant at Claycomo, Missouri, show the use of fluorescent lighting installations. Both installations use ADVANCE "Certified" fluorescent lamp ballasts, specified by the fixture manufacturers responsible for the lighting efficiency. Why not take a tip from successful contractors and use dependable ADVANCE Ballasts too.



*Designed & Engineered*  
BY THE  
WORLD'S LARGEST MANUFACTURER  
DEVOTED *Exclusively* TO THE PRODUCTION OF  
FLUORESCENT LAMP BALLASTS



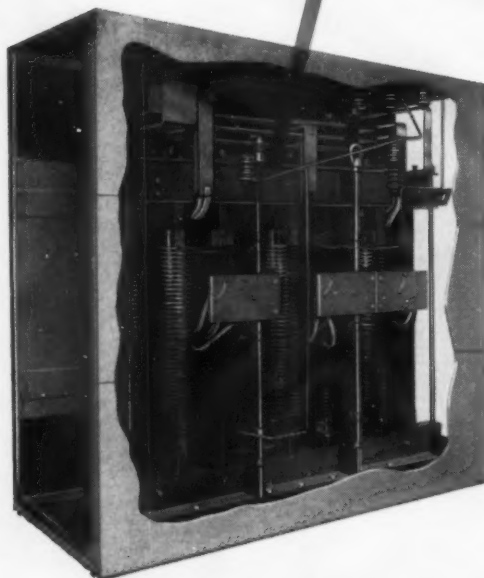
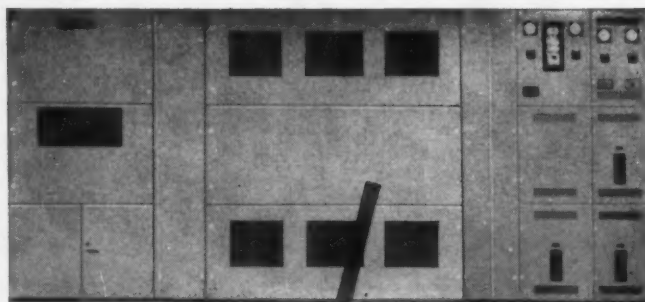
Cable Address "ADTRANS"  
2950 N. WESTERN AVENUE, CHICAGO 18, ILLINOIS, U.S.A.

# PROTECT YOUR INVESTMENT

**Specify KUHLMAN power  
center transformers —  
built for dependable service —  
designed for your  
job specifications**

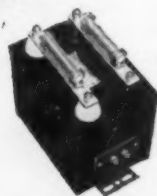
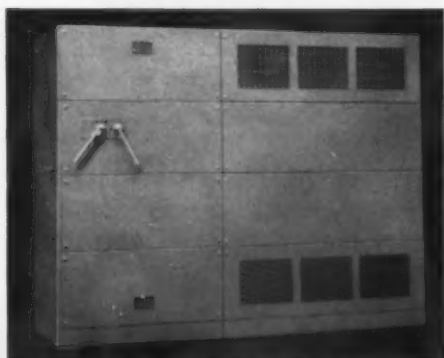
## KUHLMAN Dry-Type Transformers

- Class "B" insulation is designed for a maximum 80° rise over ambient temperature of 40°C.
- Dry-Types can be supplied as core and coil units or as complete sections with sheet metal enclosures.
- All units match specified high and low voltage switchgear and can be installed close to the center of the load areas, thus providing better voltage regulation and eliminating long secondary runs of copper.
- Standard assemblies can be used as either right or left hand units.
- Taps are conveniently located.
- Automatic forced air cooling can be provided for additional over-load capacity.



## PUT POWER WHERE YOU WANT IT—YOUR CHOICE OF KUHLMAN DRY-TYPE

Dry-type Power center for supplying power to individual production machines — reduces line losses and voltage drops — is installed at machine location.



Potential and current transformers for operating relays, tripping devices, and metering applications.

Dry-Type distribution transformers, either floor or wall mounted—600 volts and below, for machine tools and lighting circuits.

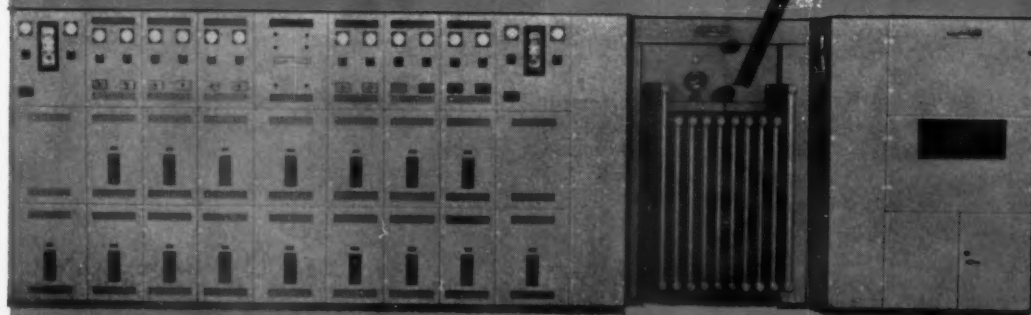
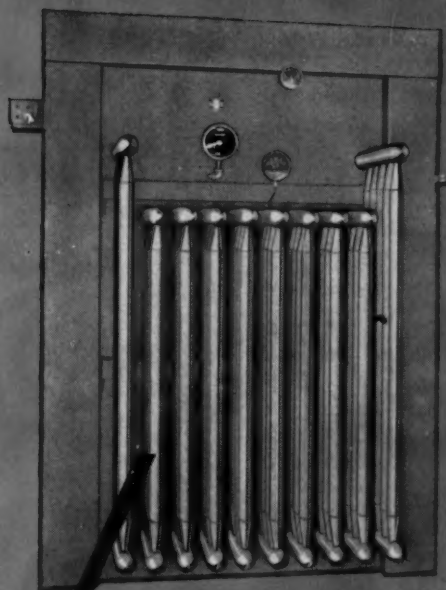


**KUHLMAN ELECTRIC CO. BAY CITY, MICH. • CRYSTAL SPRINGS, MISS.**

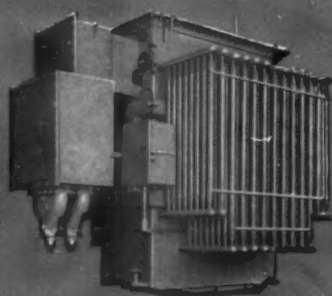
# IN MODERN PLANT EQUIPMENT

## KUHLMAN Liquid-filled Transformers

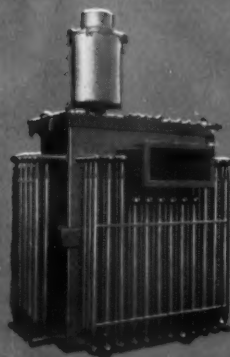
- Standard accessories on all units include: ground pad, tap changer and handle, name plate, magnetic liquid level gauge, top filter valve, liquid temperature indicator, drain valve, pressure vacuum gauge, and jacking bosses.
- Special accessories include: Provisions for fans and forced air cooling, alarm contacts for temperature, pressure, and liquid level gas absorber and other special equipment.
- Where required units are supplied with a safe, non-inflammable cooling fluid and can be installed without vault protection.
- Kuhlman liquid-filled transformers are designed to match the specified low and high voltage switchgear for either flush end or throat connections.
- Units are compact for easy installation and quick plant change-overs.



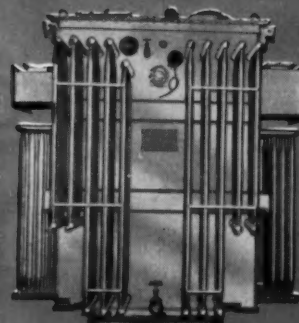
## OR LIQUID-FILLED TRANSFORMERS FOR EVERY JOB APPLICATION



Typical outdoor liquid-filled transformer equipped with high voltage switches serves as a power center for distribution systems.



Liquid-filled unit equipped with a gas absorber and a relief device for relieving abnormal pressures.



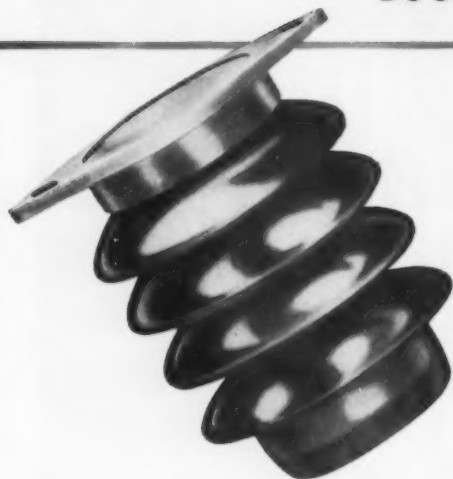
Liquid-filled unit with throats for indoor or outdoor installation in locations where transformers are throat connected to switch-gear sections or bus.

SALINAS, CALIFORNIA

# IMPROVE YOUR THIRD

*with*

**BOOST SAVINGS IN ENGINEERING, EQUIPMENT,**



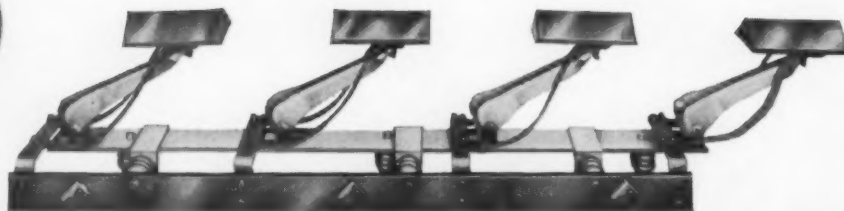
## **PETTICOAT INSULATORS FOR THIRD RAIL SERVICE TO 4160 VOLTS**

**HIGH MECHANICAL STRENGTH**, with tensile and cantilever properties for heavy-duty over or under-running applications. Extra heavy petticoats to stand industrial abuse.

**QUALITY MATERIALS**, using high grade wet process, glazed porcelain to assure permanent efficiency.

**UNSURPASSED ELECTRICAL PROPERTIES**, with extra leakage distance and self cleaning surface to lessen effect of contaminations leading to shut-downs. Petticoat insulators also recommended for dirty low voltage systems.

**ALL PURPOSE HARDWARE** available for rail, angle or wire service.



## **COLLECTORS FOR UNDER-RUNNING CONTACT SYSTEMS**

**HIGH AMPERAGE** . . . collector arms used in multiple units for high capacity (2400 amp. shown).

**DEPENDABLE** . . . contact surface protected against sleet and dirt; bearings sealed against grit.

**LONG LIFE, HEAVY DUTY** . . . vital parts are stainless steel; contacts are extra large.

**NON-ARCING BEARINGS** . . . integral insulating bushings insure current transfer through shunts.

**WIDE OPERATING RANGE** . . . will accommodate vertical and horizontal misalignments.

**ELECTRIC SERVICE MFG. CO.**



# RAIL INSTALLATIONS

## KEYSTONE PRODUCTS

### INSTALLATION, MAINTENANCE AND PRODUCTION

#### STRAIN INSULATORS FOR CRANE BRIDGE ANGLES

This new insulator now TOPS in the field.

- **SMALLEST SIZE:** 2" diameter; accommodates smaller angles and permits closest conductor spacings.
- **FUNCTIONAL SHAPE:** small end provides extra clearance for collector.
- **LONGER LEAKAGE DISTANCE:** reduces possibility of shut-downs due to contamination.
- **INSULATORS COST LESS** than wooden supports.
- **STEEL INSULATOR INSERTS** are free of shrinkage . . . never vibrate loose.
- **HIGH STRENGTH** — tensile and cantilever — minimizes breakage.
- **STRAIN HARDWARE** available for all insulators.



#### XVE "Econo-Mizer" CRANE COLLECTOR FOR PICK-UP WIRE SYSTEMS

The XVE "Econo-Mizer" crane collector. Includes all advantages of strain insulator above, plus . . .

- **NEW LOW COST:** entire assembly costs less than castings alone for other type collectors.
- **MULTIPLE SAVINGS:** replacement of complete body assembly is quicker . . . easier . . . cheaper than repairing.
- **LONGER SERVICE:** carbon contacts give greater life and reduce arcing. Graphite lubrication prolongs wire life.
- **INTEGRATED CONTACT** electrically bonded to collector body for uniform efficiency; shaft is permanent part of insulator.\*
- **COMPACT:** designed for closest wire spacings.

\*Collector also available without insulator.



Photo: Actual Size

Write for details on these third rail system improvements

**Philadelphia 32, Pa.**

# QUICK GUIDE

## TO ELECTRICAL WIRE AND CABLE SELECTION

### *Helpful specifications for frequently needed types*

To meet practically any electrical service requirement... for either low or high voltage... Rome Cable offers a well-rounded line of electrical wires and cables. Conductors may be of copper or aluminum. Described on these pages are some of the more

frequently used types which are generally available from Rome Cable factory or warehouse stocks.

In addition to types shown, Rome Cable engineering and research stand ready to work with you in the design of such special cable constructions as may best service your particular requirement.



**Power Cables—0 to 15,000 Volts.** For aerial, duct or direct-in-earth installation.

#### **RoMarine-RoPrene®**

This economical combination of RoMarine, heat- and moisture-resistant rubber insulation, with RoPrene (Neoprene) sheath is a multi-purpose power cable—generally recommended for 600-volt service.

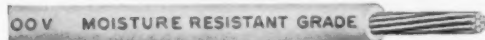
#### **RoZone®-RoPrene**

Here is a premium quality power cable highly recommended for either low- or high-voltage circuits where

stability of electrical characteristics and exceptionally long life are factors. Manufactured for services up to 15,000 volts, this cable combines superior ozone-resistant, oil-base insulation with the ruggedness of a RoPrene (Neoprene) sheath. When specified, this cable can be supplied with a RoSeal (flame-resistant polyethylene) sheath, thus combining with RoZone the advantages of a thermoplastic covering.

RoMarine-RoPrene and RoZone-RoPrene are high quality cables having economy in their versatility of installation and long life of dependable service. They may be installed aerially, in conduit or duct, buried directly in earth, or in circuits combining all three. This means less inventory with fewer terminations and splices.

Manufactured in a full range of sizes as single-, two- or three-conductor.



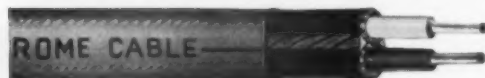
**Thermoplastic Building Wire—600 Volts**  
Rome Synthinol®—Type TW

A polyvinyl chloride thermoplastic insulated building wire, approved by Underwriters' Laboratories, Inc., for use in dry or wet locations. It is highly resistant to heat, sunlight, oils, acids, alkalis, moisture and flame.



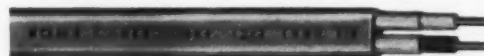
**Rubber and Braid Building Wire—600 Volts.** Types R and RH-RW

Code Grade, Type R (60°C.), and "Dual-Purpose" Moisture- and Heat-Resistant Grade, Type RW (60°C.)—Type RH (75°C.), rubber-insulated and braided building wires carry full approval of Underwriters' Laboratories, Inc. Available as solid or stranded in standard range of sizes and colors.



**Nonmetallic Sheathed Cable—600 Volts**  
Rome RoFlex—Type NM

Conductors are insulated with high quality thermoplastic compound and outer braid is of glass over which is an improved gray finish which is non-flaking. Available in sizes 14 AWG to 4 AWG, 2- and 3-conductor. Approved by Underwriters' Laboratories, Inc.



**Multi-purpose Nonmetallic Sheathed Cable—600 Volts.** Rome FlexAll—Types UF and NMC

Approved by Underwriters' Laboratories, Inc., as Type UF (underground feeder) and Type NMC (nonmetallic sheathed cable—corrosive resistant). Particularly recommended for between-building wiring; farm, industrial and residential yard lighting; interior wiring of livestock buildings, dairies, breweries, packing houses, cold storage and ice plants.



### Service Entrance Cable—600 Volts. Type SE, Style U

Offers the advantages of heat-resistant rubber insulation, plus long-lived protective braid of combined glass and presaturated yarns with improved gray finish which is nonflaking. U/L approved.



### Service Drop Cable—600 Volts. Rome Triplex—Copper and Aluminum

#### RoPrene and RoLene

A new development embodying the time-proven construction of insulated power conductors spiraled around a bare neutral for mechanical support. Power conductors are insulated with RoPrene (Neoprene), RoLene (polyethylene) or RoMarine-RoPrene. A TreePlex type is designed for tree conditions.



### Machine Tool and Control Wire. Rome Synthinol

Designed for the wiring of automatic machine tools and control circuits, this product has superior characteristics of long life, high resistance to heat, oils, chemicals and solvents and uniformly small diameters for more room in tight places. Available in sizes 18 AWG through 4/0 AWG with thermoplastic insulation of clear permanent colors. Conforms to National Machine Tool Builders Association Standards.

### SALES OFFICES

Rome Cable Corporation, 500 Ridge Street, Rome, New York—Plants at Rome, N. Y., and Torrance, Calif. (Steel Conduit).

\*Atlanta, Ga., 156 Simpson, N.W. • Boston 10, Mass., 80 Federal St. • Chicago 39, Ill., 4505 W. Grand Ave. • \*Dallas 26, Texas, Peabody Bros., 3015 Taylor St. • Houston 2, Texas, Peabody Bros., 866 Merchants & Mfrs. Bldg. • Cleveland 14, Ohio, 818 Society for Savings Bldg. • \*Denver 4, Colo., 1160 Elati St. • Detroit 2, Mich., New Center Bldg. • Kansas City 11, Mo., 406 West 34th St. • \*Los Angeles 22, Cal., 2510 South Main Ave. • New York 17, N. Y., 60 East 42nd Street • Philadelphia 7, Pa., 12 South Twelfth St. • Pittsburgh 22, Pa., 1901 Oliver Bldg. • Portland 5, Oregon, 1224 S.W. Morrison St. • Tulsa 14, Okla., Peabody Bros., 2438 East 21st St. • St. Louis 17, Mo., 6617 Clayton Road • \*St. Paul 4, Minn., 345 N. Wheeler Ave. • \*Salt Lake City 1, Utah, 230 South 4th, West • \*San Francisco 24, Cal., 1100 Selby Street • \*Seattle 4, Wash., 3430 Fourth Ave., S. • \*Indicates warehouse location.



### Underground Service Entrance Cable—600 Volts. RoMarine-RoPrene, Type USE

May be installed directly in earth, in conduit and aerially, or in runs combining all three. Combines RoMarine, a high moisture-resistant insulation with all-resistant RoPrene (Neoprene) sheath. Easy to splice and terminate. Easier to handle and less costly than lead sheath. Approved by Underwriters as Type USE.



### Airport Lighting Cables. Types A and B CAA Spec. L-824

Rome airport lighting cables were first to obtain approval of CAA under requirements of Specification L-824. This and many other types are supplied in single and multi-conductor constructions. RoMarine (Type RR) or RoZone (Type ROR) are the more popular insulations, under a RoPrene (Neoprene) sheath. Voltages range from 600 through 5000 volts.



### Preassembled Aerial Power Cables

Where aerial installation is involved, multiple conductor cables may be factory preassembled with supporting messenger of bare copper or copperweld.

*It Costs Less to Buy the Best*



**ROME CABLE**  
*Corporation*  
ROME • NEW YORK  
TORRANCE • CALIFORNIA

# NEW CURTIS SCHOOL CORRIDOR LIGHTING UNITS

## INCANDESCENT SQUARE RECESSED



**A square recessed incandescent downlight that can be recessed into a 12" opening in any type ceiling construction.**

This new Curtis recessed unit is for use with either 150-W, 200-W or 300-W incandescent lamps. A specially designed lamp holder plate permits easy adaption for correct positioning of these three different wattage lamps. The hinged door accommodates either a variety of lenses or a louver. Units pass Underwriters approval when installed singly or when grouped or patterned together.

## PRINCESS CORRIDOR LUMINAIRE



**A new completely enclosed Fluorescent Luminaire for 4' and 8' Rapid Start or Slimline lamps.**

This completely enclosed luminaire is ideal for corridors and other areas where wide light distribution is desirable. The white plastic polystyrene plastic panels may be easily removed for cleaning or lamp replacement. Units may be installed individually or in continuous lines, close-ceiling or pendant mounted.

## LOUVERED CORRIDOR LUMINAIRE



**A distinctive Fluorescent Luminaire, with attractive white enameled steel louvers for 4' and 8' Rapid Start or Slimline lamps.**

This new Curtis all steel luminaire is finished white baked Fluracite enamel. It is a highly efficient direct unit designed to give 25° lengthwise shielding. The louver is hinged from either side for fast, easy re-lamping or cleaning without the use of tools. Units may be close-ceiling or pendant mounted individually or in continuous lines.

**Write for complete, descriptive literature on these new Curtis corridor units.**



**CURTIS LIGHTING, INC.**

**6135 WEST 65th STREET CHICAGO 38, ILLINOIS**



NEW! IMPROVED  
COMPLETE LINE OF



# HANDY BOXES AND COVERS

## COVER SCREW

Cover mounting screws are assembled and self-retained in covers. Cannot shake out, but easily removed if desired. No fiber washers or extra parts used to retain screws.



Bright Plated Finish  
on Covers and Boxes

Deeper Cover  
Neater  
Appearance

Integral  
Ears

Uniform Weight  
One-Piece Box!  
Corners are full  
metal thickness  
smoothly rounded  
and strong...  
won't crack

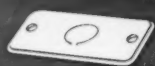
Knockouts  
Easily  
Removed

Strong Flat Bottom for Easier,  
Firm Mounting

OVERLAPPING COVERS FOR EVERY WIRING REQUIREMENT!



No. 860  
Blank



No. 861  
1/2" Knockout



No. 863  
Single Knockout



No. 864  
Duplex



No. 865  
Toggle Switch

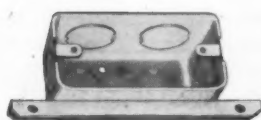


No. 866  
Demand

## RACO HANDY BOXES ARE ONE PIECE DRAWN STEEL!

Standard Sizes—4" long, 2 1/8" wide by 1 1/2", 1 7/8" or 2 1/8" deep

Available with or without brackets in all sizes

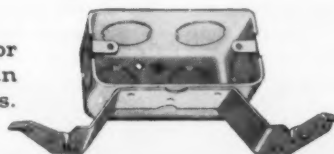


**A** Bracket, 1/2" knock-  
outs in 1 1/2" and 1 7/8"  
deep boxes. Either  
1/2" or 3/4" knockouts  
in 2 1/8" deep boxes.

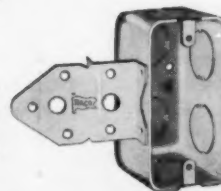


**F** Bracket, 1/2" knock-  
outs in 1 1/2" and 1 7/8"  
deep boxes.

**O** Bracket, 1/2" or  
3/4" knockouts in  
2 1/8" deep boxes.



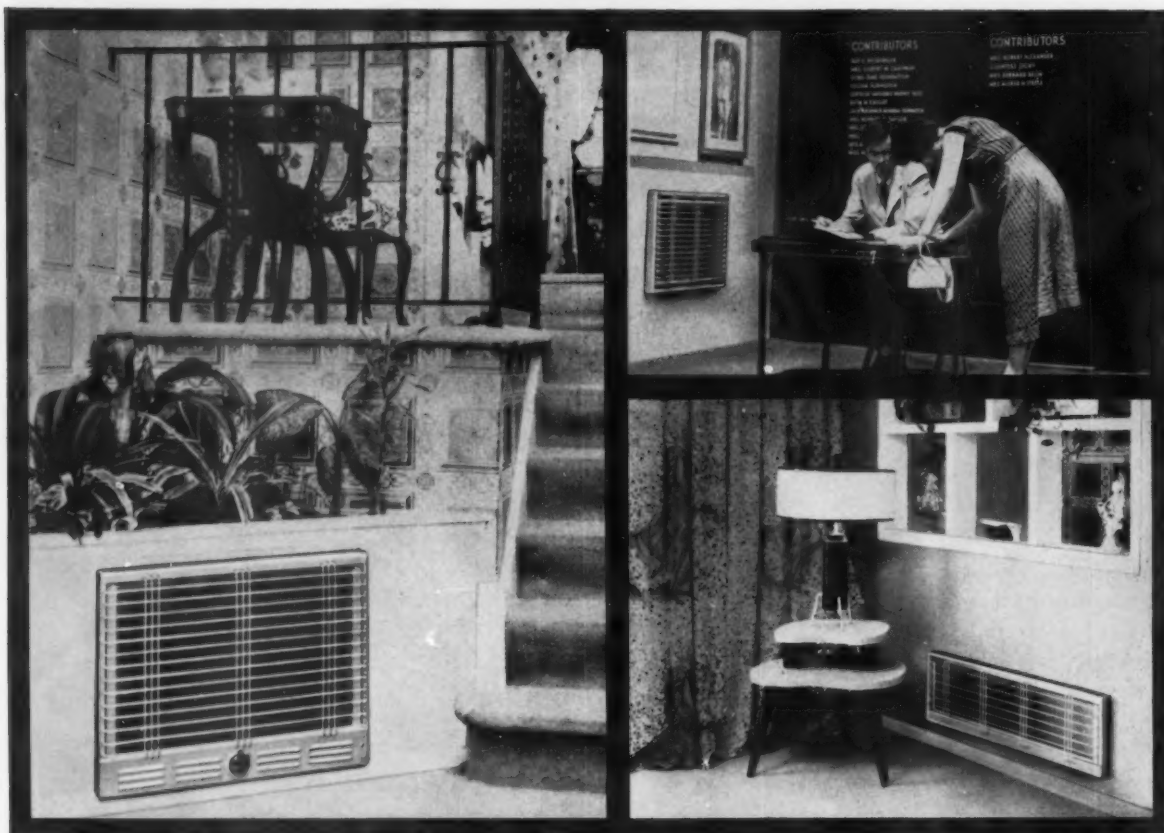
**B** Bracket, 1/2" or 3/4"  
knockouts in 1 1/2"  
and 2 1/8" deep boxes.



"A RACO BOX FOR EVERY NEED"

**ALL-STEEL EQUIPMENT INC.**

Aurora, Illinois



Installation photographs courtesy of Berko Electric Manufacturing Corp.

## You can recommend this radiant heat panel confidently

The wall-mounted heating units illustrated above are made and sold by the Berko Electric Manufacturing Corp., Queens Village, N. Y. Owners of such Berko heaters are enthusiastic about the comfort, convenience and safety they provide.

The heating elements in these heaters are PYREX Radiant Glass Panels. You can expect your customers to have confidence in any heater you may recommend with a PYREX panel heating element, as they are already familiar with other PYREX brand products having excellent heat-resistant qualities.

PYREX Radiant Panels are made of heat-resistive glass with an electrically conductive coating inseparably bonded to the entire back surface. Thin silver strips bonded to opposite edges of the

panel distribute the current *evenly* over its entire length and breadth. This provides completely uniform heat radiation.

### Efficient

PYREX Radiant Panels radiate about double the heat of a metal-finish radiator at the same operating temperature. This high degree of efficiency helps bring the cost of electric heat within reach of more homeowners. Also, there is little initial surge of current when these panels are turned on—another point of economy.

The coated side of the panel itself acts as a heat reflector. With the addition of a metal reflector, as much as 80% of the input energy is available as heat radiation from the panel's uncoated side.

At 400°F. over 75% of the panel's heat energy is emitted in wave lengths of four microns and longer. This energy provides instant warmth and comfort.

### Customer benefits

PYREX panels provide clean, draftless heat and the panels themselves are easy to wipe clean. Free dust particles will not adhere to or carbonize on them. In-the-wall installation leaves completely free floor space and installation is easy. There's space saved, too, because there is no heating room. Every room is individually thermostatically controlled. The glass is high in physical strength. It's safe and durable.

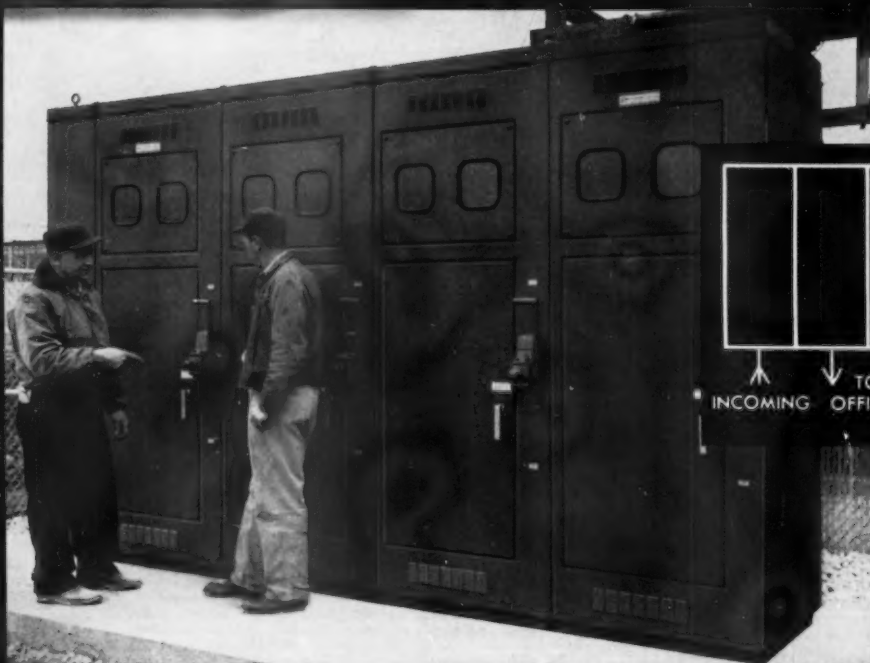
For additional technical information on PYREX Radiant Panels, write, wire or phone.



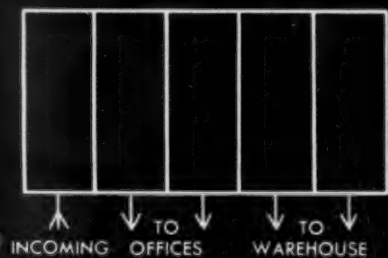
**CORNING GLASS WORKS, CORNING, N.Y.**

95 Crystal Street

*Corning means research in Glass*



Wm. Wetsig (right), Jewel Tea Co. engineer, confers with John Corsiglia of Hyre Electric Co. installation contractor.



**CUT THE COST OF YOUR HIGH-VOLTAGE**

**SUPPLY SYSTEM BY SPECIFYING S&C**

**METALCLAD SWITCHGEAR... IT DOES THE JOB**

**FOR HALF THE MONEY**

Get off to a good start on the plans for your electrical system by selecting S&C Metalclad Switchgear. That is what A. Epstein & Sons did for Jewel Tea Company's new office-warehouse building. The savings made at the switching center were considerable, and they were reflected in a lower cost high-voltage supply system.

S&C Metalclad Switchgear provides all the necessary protection and switching for high-voltage feeders—at about half the cost of other types of metalclad switchgear. A simplicity of design assures complete dependability with far less maintenance.

Electrical engineers and contractors alike find the experienced recommendations of S&C field engineers extremely valuable in reducing electrical construction costs. Write or phone your nearest S&C field office... they will be glad to assist you.



**MR. SOL KRIVO**

Chief Electrical Engineer for A. Epstein & Sons—Chicago architect-engineers—

planned the high-voltage supply system for the newest Jewel Tea Company building. He says, "Since S&C were the originators of this type of outdoor metalclad switchgear, we are sure they have the 'know-how' to furnish equipment best fitted to our jobs. Our customers have been completely satisfied by the simplicity, low cost, and easy maintenance of S&C Metalclad Switchgear."



*Specialists in  
High-Voltage Switchgear  
for Electric Utilities  
since 1910*

**S & C ELECTRIC COMPANY**

4433 RAVENSWOOD AVENUE • CHICAGO 40, ILLINOIS, U. S. A.

In Canada: S & C ELECTRIC CANADA, LTD.  
8 Vance Road  
Toronto 14, Ontario

Consult your telephone directory. Sales offices in Birmingham, Boston, Buffalo, Chicago, St. Louis, Cleveland, Dallas, Dearborn, Denver, Houston, Huntington, Indianapolis, Jersey City, Kansas City, Little Rock, Memphis, Minneapolis, New Orleans, Philadelphia, Pittsburgh, Portland (Ore.), St. Petersburg, Salt Lake City, San Francisco, San Gabriel (Los Angeles), Seattle, Syracuse, Washington, D. C.

# A DIGEST OF DAY-BRITE DATA

## DIRECT TYPE FIXTURES

### SLIMLINE "RANGER"



OPEN TYPE FIXTURE

LAMPS		FIXTURE DIMENSIONS			CATALOG
NO.	SIZE	LENGTH	WIDTH	HEIGHT	NUMBER
2	8-FT.	95½"	7"	4¼"	96260

ALSO AVAILABLE FOR 4-FOOT RAPID-START LAMPS

## RANGER DATA

**APPLICATION**—Unit or continuous. **MOUNTING**—Surface or suspension. **CONSTRUCTION**—Die-formed and welded heavy-gauge steel. **FINISH**—HOT-BONDED SUPER-WHITE enamel. **WIRING**—TURRET sockets. Instant start HPF 430-milliamperes Certified ballasts. UL approved.

© G. E. Co.

### SLIMLINE "PLEXOLINE-2"



WITH LOW BRIGHTNESS HOLOPHANE CONTROLLENSES\*

LAMPS		FIXTURE DIMENSIONS			CATALOG
NO.	SIZE	LENGTH	WIDTH	HEIGHT	NUMBER
2	8-FT.	96¾"	12¼"	4"	97720

ALSO AVAILABLE FOR 4-FOOT RAPID-START LAMPS

## LENS PLEXOLINE DATA

**APPLICATION**—Unit or continuous. **MOUNTING**—Surface or suspension. **CONSTRUCTION**—Die-formed steel. One-piece enclosure and chassis. Reflector plates for 100% direct distribution. **SHIELDING**—No. 9015 Controlens\* in separable hinged frames. **WIRING**—CBM Certified ballasts. Individually wired for unit, continuous, surface or suspension installation. UL approved.

## FLUORESCENT "MOBILEX"

A NEW RECESSED LIGHTING SYSTEM FOR USE WITH GRID TYPE SUSPENDED CEILING

\* © Owen-Corning Fiberglas Corp.



GLASS  
LOUVERS  
PLASTIC

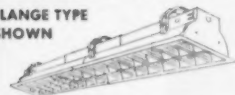
2-LAMP FLUORESCENT			3-LAMP FLUORESCENT			4-LAMP FLUORESCENT		
LAMP SIZE	FIXTURE DIMENSIONS	CATALOG NO.	LAMP SIZE	FIXTURE DIMENSIONS	CATALOG NO.	LAMP SIZE	FIXTURE DIMENSIONS	CATALOG NO.
2-FT. 24"x24"	2G270	2-FT. 24"x24"	2G370	2-FT. 24"x24"	2G470	2-FT. 24"x24"	2G470	2G470
4-FT. 24"x48"	4G270	4-FT. 24"x48"	4G370	4-FT. 24"x48"	4G470	4-FT. 24"x48"	4G470	4G470
2-FT. 24"x24"	2G260	2-FT. 24"x24"	2G360	2-FT. 24"x24"	2G460	2-FT. 24"x24"	2G460	2G460
4-FT. 24"x48"	4G260	4-FT. 24"x48"	4G360	4-FT. 24"x48"	4G460	4-FT. 24"x48"	4G460	4G460
2-FT. 24"x24"	2G290	2-FT. 24"x24"	2G390	2-FT. 24"x24"	2G490	2-FT. 24"x24"	2G490	2G490
4-FT. 24"x48"	4G290	4-FT. 24"x48"	4G390	4-FT. 24"x48"	4G490	4-FT. 24"x48"	4G490	4G490

## MOBILEX DATA

**APPLICATION**—Single unit, end to end, side to side. **MOUNTING**—Recessed into grid type suspended ceiling. Fixture rests on interlocking "tees" which also support Fiberglas® Ceiling Board. Plange type Mobilex also available for conventional ceilings. **SHIELDING**—Skytex glass panels, Boxco® louvers, or moulded plastic panels. **FINISH**—HOT-BONDED SUPER-WHITE enamel. **WIRING**—Sockets, Certified ballasts and NO-BLINK type starters on 20-watt units. All 40-watt units furnished with RAPID-START ballasts. UL approved.

## ALZAK PARALOUVER

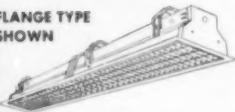
FLANGE TYPE SHOWN



FLANGE TYPE		SNAP-IN TYPE	
LAMPS	FIXTURE LENGTH	LAMPS	FIXTURE LENGTH
2/4-FT.	48"	2/4-FT.	48"
CATALOG NO. 4F201		CATALOG NO. 4M201	

## EGG-CRATE LOUVERS

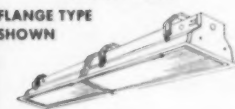
FLANGE TYPE SHOWN



LAMPS	FIXTURE LENGTH	CATALOG NUMBER	LAMPS	FIXTURE LENGTH	CATALOG NUMBER
2/4-FT.	48"	4F211	2/4-FT.	48"	4M211
3/4-FT.	48"	4F311	3/4-FT.	48"	4M311

## HINGED GLASS ENCLOSED

FLANGE TYPE SHOWN



LAMPS	FIXTURE LENGTH	CATALOG NUMBER	LAMPS	FIXTURE LENGTH	CATALOG NUMBER
2/4-FT.	48"	4F220	2/4-FT.	48"	4M220
3/4-FT.	48"	4F320	3/4-FT.	48"	4M320

## TROFFER DATA

### PARALOUVER

Diffuse Alzak aluminum troffers provide low brightness contrast. Center "V" louver and patented lateral louvers interlocked for strength. Available also in all-white finish and in Slimline.

### HINGED SERIES

Four shielding elements available: ribbed Skytex glass panels, Boxco louvers, egg-crate louvers and low brightness 9015-DB Controlens. Each shielding element is separably hinged, allows hinging from either side. Available also in Slimline.

### GENERAL

**CONSTRUCTION**—Die-formed through-out. Removable wireway cover. Continuous wiring channel. **FINISH**—HOT-BONDED SUPER-WHITE enamel. **WIRING**—sockets, CBM Certified ballasts. RAPID-START ballasts, UL approved.

## TROFFER ACCENT UNITS



ADJUSTABLE—FLANGE TYPE  
CATALOG NO. 80137  
ADJUSTABLE—SNAP-IN TYPE  
CATALOG NO. 80127  
FIXED—FLANGE TYPE  
CATALOG NO. R-80135  
FIXED—SNAP-IN TYPE  
CATALOG NO. R-80125

## PLASTER FRAMES

FOR	CATALOG NO.
Accent Unit—12"x12"	7770
4-ft. Troffer Units	7771
8-ft. Troffer Units	7771-8

Die-formed "T" formation provides rigid strength. Holes in rails for wiring to furring channel. Spacer bars maintain correct framed opening during plastering.



## ONE-LAMP RECESSED DUO-FRAME UNITS



WITH HOLOPHANE CONTROLLENSES\*  
© Holophane Co., Inc.

LAMP SIZE	LENS SIZE	BOX DIMENSIONS			CATALOG NUMBER
		DEPTH	WIDTH	LENGTH	
150W	8½"	7"	10½"	10½"	RS-851-RV
150W	8½"	9½"	10½"	10½"	RS-851-RHV
200-300W	12"	9"	14½"	14½"	RS-121-RH
200-300W	12"	11½"	14½"	14½"	RS-121-RHV


## DUO-FRAME DATA

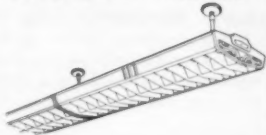
Die-formed, riveted and welded construction. Two-piece frame. Inner frame mounted to drop hinges—opens easily for servicing. Vertical lamp mounting units (RVH) have Holophane prismatic glass reflectors. Horizontal lamp mounting units (RH) have specular Alzak reflectors. Porcelain sockets. UL approved. Four feet of flex with wire and box connector furnished with all fixtures.




# A HANDY SPECIFYING CHECK-LIST

## SEMI-DIRECT FIXTURES


<b>SLIMLINE "LUVEX"</b> <b>2- AND 4-LAMP</b> 	<b>8" SUSPENSION</b>			<b>24" SUSPENSION</b>			<b>LUXEY DATA</b> <b>APPLICATION</b> —Unit or continuous. <b>MOUNTING</b> Recommended for suspension only. <b>CONSTRUCTION</b> —Die-formed and welded steel. All metal. One-piece enclosure with interlocked louvers. <b>FINISH</b> —HOT-BONDED SUPER-WHITE enamel. <b>WIRING</b> —CBM Certified ballasts. Individually wired. UL approved. Fill-in sections available. 2-Lamp and 4-Lamp 4-Foot Rapid-Start Luxe also available.
	<b>FIXTURE LENGTH</b>	<b>CUT-OFF</b>	<b>CATALOG NUMBER</b>	<b>FIXTURE LENGTH</b>	<b>CUT-OFF</b>	<b>CATALOG NUMBER</b>	
	96½"	35°-25°	<b>96266-8</b>	96½"	35°-25°	<b>96267-8</b>	
	96½"	35°-45°	<b>96296-8</b>	96½"	35°-45°	<b>96297-8</b>	
	96½"	35°-25°	<b>96468-8</b>	96½"	35°-25°	<b>96469-8</b>	
4-LAMP 2-LAMP	96½"	35°-45°	<b>96498-8</b>	96½"	35°-45°	<b>96499-8</b>	

<b>RAPID-START "VIZ-AID"</b> 	<b>STANDARD FINISH</b>			<b>ALL-WHITE FINISH</b>			<b>VIZ-AID DATA</b> <b>APPLICATION</b> —Unit or continuous. <b>MOUNTING</b> —Surface or suspension. <b>CONSTRUCTION</b> —Die-formed and welded steel. Interlocked louvers. Ribbed Plastic side panels. <b>FINISH</b> —(Standard) Specular Alzok V-center louver. Lateral louvers and chassis in SUPER-WHITE. Enclosure frame in lustre aluminum. (All white) HOT-BONDED SUPER-WHITE enamel throughout. <b>WIRING</b> —CBM Rapid-Start ballasts. Individually wired. UL approved.
	<b>LAMPS</b>	<b>FIXTURE LENGTH</b>	<b>CATALOG NUMBER</b>	<b>LAMPS</b>	<b>FIXTURE LENGTH</b>	<b>CATALOG NUMBER</b>	
	2/4-FT.	49"	<b>46202-4</b>	2/4-FT.	49"	<b>46230-4</b>	
	4/4-FT.	49"	<b>46432-4</b>	4/4-FT.	49"	<b>46462-4</b>	

<b>SLIMLINE "PLEXOLINE"</b> <b>2- AND 4-LAMP</b>  <b>LOUVERED</b>	<b>LAMPS</b>	<b>FIXTURE DIMENSIONS</b>			<b>CATALOG NUMBER</b>	<b>LOUVERED PLEXOLINE DATA</b> <b>APPLICATION</b> —Unit or continuous. <b>MOUNTING</b> —Surface or suspension. <b>CONSTRUCTION</b> —Die-formed and welded steel. Enclosure and chassis in one piece, removable louvers completely interlocked. Ribbed Plastic side panels. <b>FINISH</b> —HOT-BONDED SUPER-WHITE enamel. <b>WIRING</b> —CBM certified ballasts. Individually wired. UL approved. Fill-in sections and luminous side circular accent units also available for unlimited lighting patterns. Louvered Plexoline also available in Rapid-Start.
		<b>LENGTH</b>	<b>WIDTH</b>	<b>DEPTH</b>		
	2/8-FT.	96¾"	12¾"	4"	<b>97200-8</b>	
	ALSO AVAILABLE FOR 4-FOOT RAPID-START LAMPS					
	4/8-FT.	96¾"	21"	4"	<b>97400-8</b>	
ALSO AVAILABLE FOR 4-FOOT RAPID-START LAMPS						

## INDUSTRIAL FIXTURES

CFI-10	LAMPS	% UPWARD LIGHT	FIXTURE LENGTH	CATALOG NUMBER	CFI (COMFORT FOR INDUSTRY) DATA
	2/4-FT. R. S.	10%	50"	40211-4	
	2/8-FT. R. S.	10%	96 1/4"	80211-8	
	2/8-FT. Slim.	10%	96 1/4"	90211-8	
CFI-25	3/4-FT. R. S.	10%	50"	40311-4	
	3/8-FT. Slim.	10%	96 1/4"	90311-8	
	2/4-FT. R. S.	25%	50"	41252-4	
	2/8-FT. R. S.	25%	96 1/4"	81252-8	
HYDEE HANGER	2/8-FT. Slim.	25%	96 1/4"	91252-8	
	HYDEE Hanger with two 5-ft. chains, "S" hooks receptacle and cord clips			CATALOG NO. 9988	

"A-J" ADJUSTABLE HANGER		EXIT SIGNS		<p>Complete line. Units available for surface, recessed, top and end mounting. Solid or glass bottom. Metal stencil faces, 6" letters without arrow; 5" letters with arrow left, arrow right or double arrow. Red glass. Baked lustre aluminum finish. Two porcelain sockets for 25-watt A-19 lamps.</p>
	LENGTH	CATALOG NO.	SURFACE MOUNTING	
	24" <sup>1)</sup>	<b>3314-A</b>	SINGLE FACE	
	8"	<b>3318-A</b>	1 3/16" x 9 1/16" x 4 1/16"	
Swivel fittings. Over 1" vertical hand-operated adjustment. Hot-Bonded lustre aluminum enamel finish.		6" LETTERS		
		CATALOG NO. <b>3116</b>		

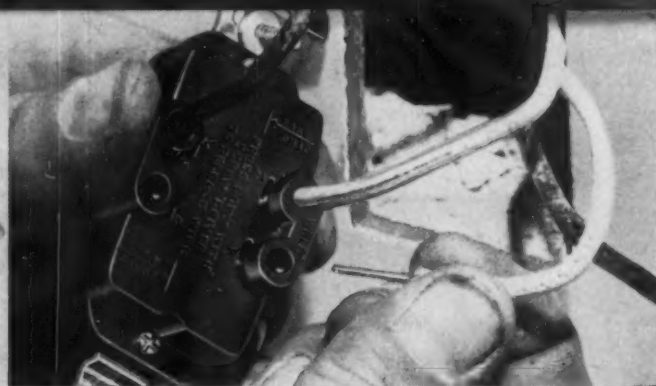
## SEE YOUR NEAREST DAY-BRITE DISTRIBUTOR

Your Day-Brite distributor can give you complete information about the items listed on these pages. He carries many of them in stock. Since a Day-Brite specification is always a guarantee of profitable business, it pays to

standardize on Day-Brite. Day-Brite Lighting, Inc., 5402 Bulwer Ave., St. Louis 7, Missouri. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario. Distributed only by leading electrical wholesalers.

5457





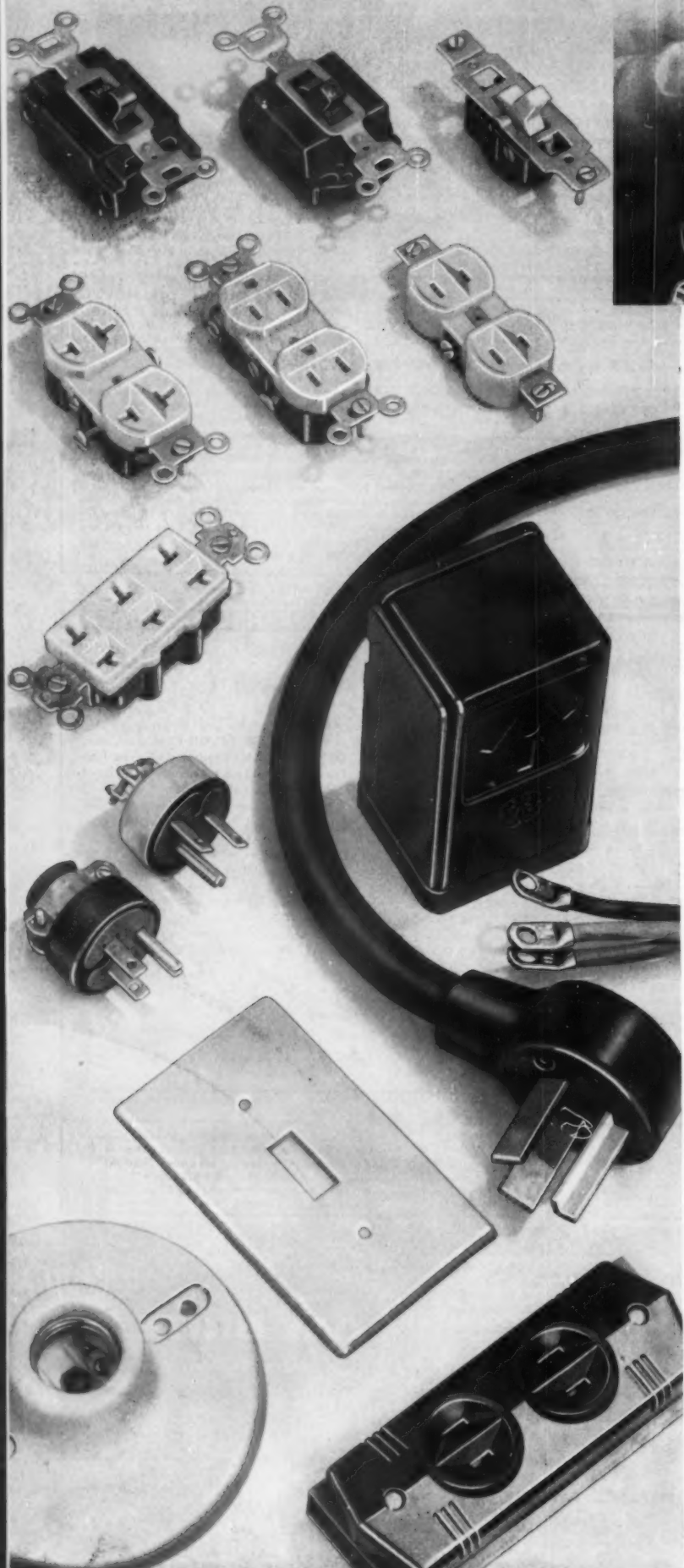
**G-E PRESSURE-LOCK TERMINALS** make wiring easy, eliminate binding screws. Wire is merely stripped and pushed into terminal for firm, dependable pressure connection. Available in a complete line of outlets, switches, and lampholders.

## For breadth of line, **LOOK**

With the newly expanded General Electric line of wiring devices you can handle any wiring job. Look over this line of switches, outlets, lampholders, plates, and special purpose devices. You'll find a wide assortment in a broad range of grades, from the finest specification and heavy duty grades to the low cost competitive grades. Here's everything needed for commercial and industrial jobs; for residential and rural jobs.

During 1954 alone the line grew by the development and introduction of 102 new products, and the redesign and improvement of 47 additional items. A completely new double outlet line was developed — smart looking in appearance, sturdy in design, and offering exclusive features. Other developments included a new line of grounding outlets and caps, an AC switch line, higher-rated mercury switches, several new remote control components, improved range outlets and cords, and a new line of dryer outlets and cords.

Yes, you can look to General Electric for more new developments in 1955 . . . wiring devices that not only answer the electrical contractor's needs, but can be depended on for extra service and long life.





**NEW G-E MERCURY SWITCH** has a handle lighted by a tiny neon lamp. Handle lights when switch is in OFF position. Will give years of service. Locates switch in dark and serves as a pilot light.



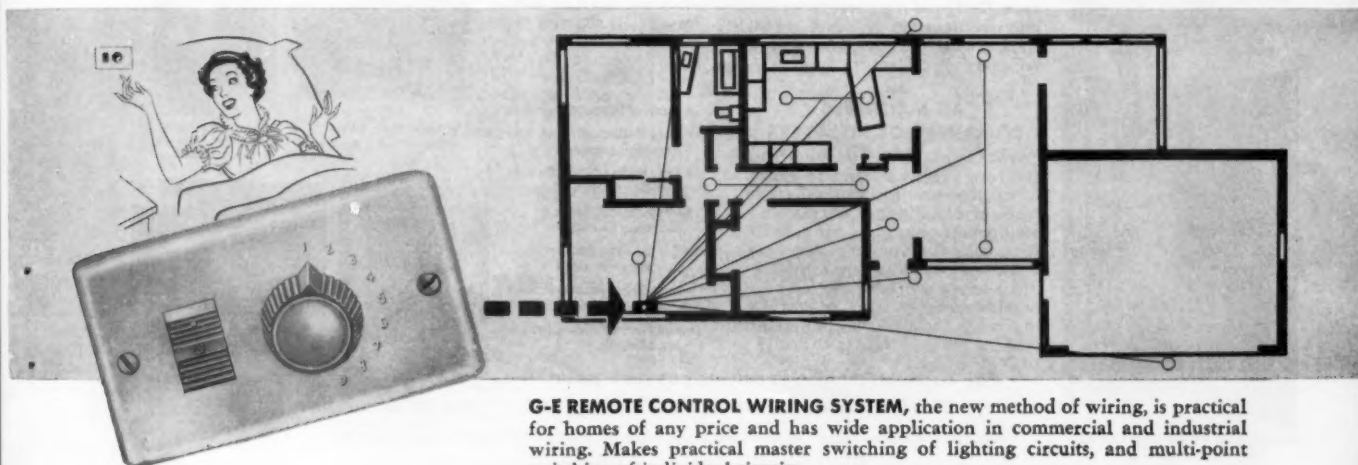
**G-E WATCH DOG STARTERS** provide automatic lockout of failing lamps, protect ballast and fixture wiring, and eliminate blinking—outlast ordinary starters up to ten to one.

product developments, and quality...

# TO GENERAL ELECTRIC

Extensive as the G-E wiring device line is, General Electric is constantly developing new products and new ideas. Some improvements are designed to save installation time and make wiring easy: like self-tapping, plaster-cleaning screws (now standard on all switches and outlets) held in position for quick mounting by fiber washers. Some G-E developments

improve the wiring system: with remote control, the convenience of multi-point and master switching is offered along with the safety of low voltage. Always, General Electric developments serve the contractor and his customers dependably and at low cost. Wiring Device Department, General Electric Company, Providence 7, Rhode Island.



**G-E REMOTE CONTROL WIRING SYSTEM**, the new method of wiring, is practical for homes of any price and has wide application in commercial and industrial wiring. Makes practical master switching of lighting circuits, and multi-point switching of individual circuits.

*Progress Is Our Most Important Product*

**GENERAL**  **ELECTRIC**



# CLARK CONTROL EQUIPMENT *emphasizes* Dependability, Accuracy and Long Life

All types of motor-driven industrial processing operations have use for Clark Electrical Control equipment. Described here are a few of the many Clark products designed to do specific jobs that contribute to increased production and efficiency.

## PUSH BUTTON STATIONS

Clark standard duty, heavy duty and heavy-duty oil-tight push button stations are available in a wide variety of enclosures, types and sizes from a single "start" button to any combination of push buttons, pilot lights, selector switches and accessories. Heavy duty types include NEMA Type 1, 4, 5 and 7 enclosures and feature double-break silver-to-silver contacts, generous wiring space, guard rings around buttons, large screw terminals.



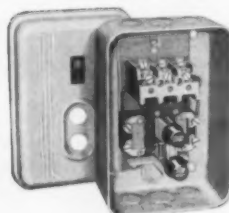
Type D, Heavy Duty



Type DB, Standard Duty



Type RN, Roughneck



Bulletin 6002, Push Button Type



Bulletin 6002, Toggle Type

## AC MANUAL STARTERS

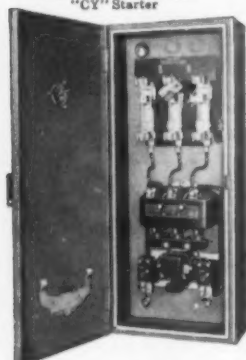
Clark Bulletin 6002 AC Manual Across-the-line starters are available in sizes 00, 0 and 1, 110 to 550V. Features include silver-to-silver contacts, ample electrical clearance, generous wiring space and bi-metallic thermal overload relays.

## AC MAGNETIC STARTERS

Clark size 0 to 3 Type "CY" starters are of heavy duty construction, with sizes 2 and 3 featuring the exclusive arc-quenching principle using strong multi-turn magnetic blowouts combined with twin break contacts. Forced arc rotation increases contact life by preventing repeated arcing at one spot. Designed for easy inspection and maintenance. Available in all standard NEMA enclosures. Other AC magnetic starters to size 7.



Bulletin 6013, Size 2 Type "CY" Starter



Bulletin 6018, Combination Starter with Disconnect Switch

## AC MAGNETIC COMBINATION STARTERS

Clark Type "CY" combination starters are available in many forms, sizes and enclosures that cut costs of installation, wiring and maintenance by using one cabinet for several functions. Included are units with fusible or non-fusible disconnect switch, air circuit breaker, non-reversing and reversing types and in a wide range of NEMA type enclosures.

**For complete specifications contact your  
Clark Distributor or write direct**

## TYPE DM MACHINE LIMIT SWITCHES

Rugged, dependable machine limit switches of simple, functional design, that provide accurate trouble-free operation and long life. Many exclusive features. NEMA Type 5 Dust-tight, and Oil-tight enclosure. Eight standard operating levers and six mounting plates for complete flexibility of application.



Bulletin 102, Type DM Limit Switch

## HATCHWAY LIMIT SWITCHES

Designed as pilot circuit devices for all heavy duty applications to limit travel or set up functions at predetermined positions. Standard weatherproof, and dust-tight enclosures available.



Bulletin 102, Type HL Limit Switch

## FOOT OPERATED MASTER SWITCHES

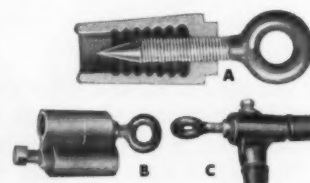
For applications requiring a rugged foot-operated pilot circuit device. One, two or four pole types in a variety of contact combinations including sequence operation. Horizontal or vertical mount.



Bulletin 101, Type FS Foot Switch

## SCREW JACK CLAMPS

Used for making dead ending connections and taking off taps in main and feeder power cables. Also for making temporary or permanent splicing connections. For cable sizes from 4/0 to 2,000,000 circular mills.

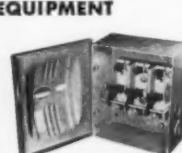


A. Single Barrel with eyebolt  
B. Double barrel - barrels parallel  
C. Double barrel - barrels at right angles

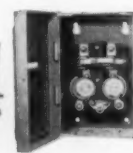
## SERVICE ENTRANCE EQUIPMENT

Through its American Electric Switch Division, Clark offers a complete line of Service Entrance Equipment including:

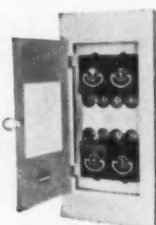
- General Purpose Switches
- Fuse Pullout Service Entrance Switches
- Fuse Pullout Main-Range-Lighting Combinations
- Door Pullout Service Entrance Switches
- Toggle Type Service Entrance Switches
- Fuse Cabinets and Branch Circuit Attachments
- Lighting and Distribution Panelboards



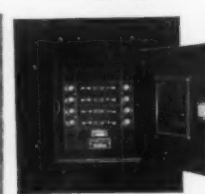
General Purpose Switch - 3 pole, fusible



General Purpose Switch front-operated toggle-type



Four-pull-out combination for main, range, drier, water heater, etc.

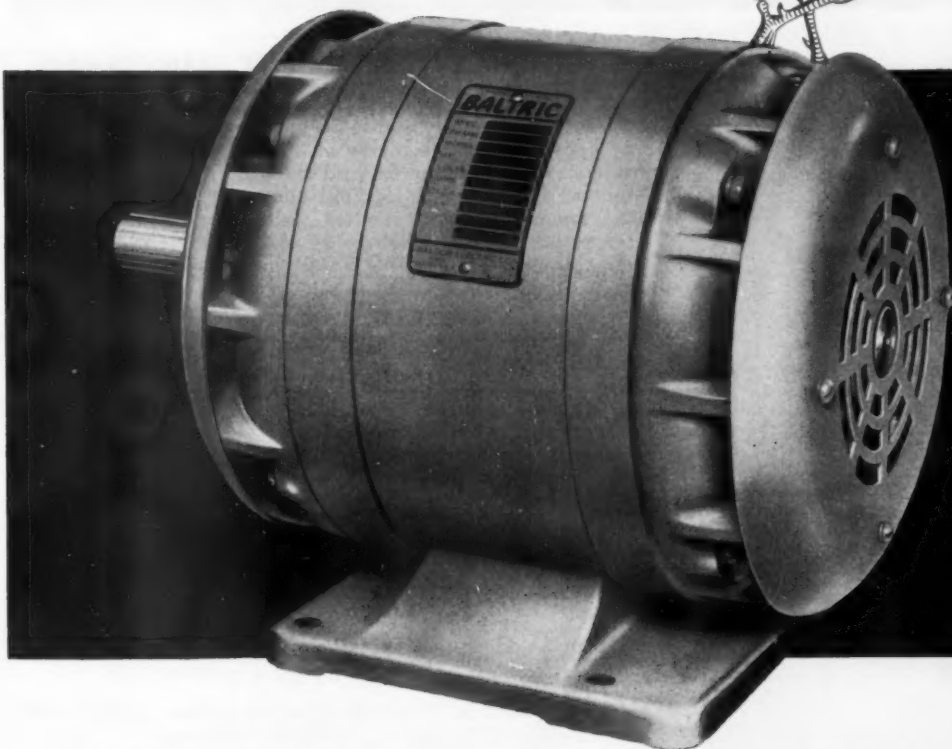


Fused type panelboard

*The* **CLARK**  **CONTROLLER** *Company*  
Engineered Electrical Control 1146 East 152nd Street ■ Cleveland 10, Ohio  
IN CANADA . . . . CANADIAN CONTROLLERS LIMITED • MAIN OFFICES AND PLANT, TORONTO



**THE BANTAM THAT PACKS A HEAVYWEIGHT PUNCH**



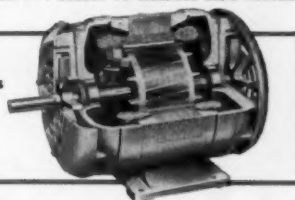
The new *Streamcooled Baltric* line of completely enclosed motors are champions, every one, all sinew and muscle . . . compact, powerful, efficient. Advanced engineering using the newest materials, enables Baltric to offer you hard-working power packages.

These are tomorrow's motors today! Greater efficiency with less weight and bulk . . . insulation is lighter and better.

Built to NEMA standards, Baltric's your best bet . . . doesn't waste space . . . doesn't waste weight . . . easier to handle and install.

BESS-B

- Exclusive One-piece Stator Frame
- Rotor Provides Improved Torque Characteristics
- Solid End Plates Completely Enclose Motor
- Base Design Permits Flexibility In Installing Or Replacing



Original *Streamcooled* Motors Also Available — Built to Former NEMA Standards

ALL BALTRIC MOTORS TOTALLY ENCLOSED AND STREAMCOOLED

**BALDOR ELECTRIC COMPANY**

Baltric Motors Are Available In Polyphase • Squirrel Cage • Induction and Single Phase • Capacitor Start • Induction Run Types

4353 DUNCAN AVENUE • ST. LOUIS 10, MISSOURI

ELECTRICAL CONSTRUCTION AND MAINTENANCE . . . MAY, 1955

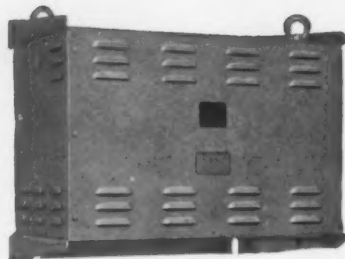
**BALTRIC**

# TRANSFORMERS

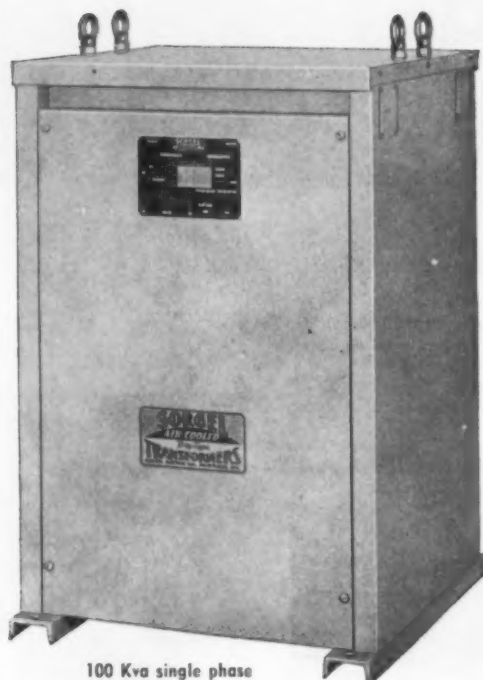
## To change higher voltage distribution service to lower voltage lighting and power circuits



1/4 Kva  
single phase  
480/240 to  
240/120 volt



15 to 50 Kva 3-phase  
wall mounting type



100 Kva single phase

### SORGEL AIR-COOLED DRY-TYPE TRANSFORMERS are the most practical type for indoor installations

Requiring no oil or liquid, they can be installed in almost any convenient place inside of buildings, without fire-proof vaults or other enclosures, and meet the requirements of the National Electrical Code. This eliminates the necessity of long runs of secondary feeders and reduces installation and wiring costs.

The transformers can be installed at load centers, using higher voltage feeders, requiring smaller copper, increasing efficiency, improving voltage regulation and reducing losses. They require no maintenance or further attention after installation.

Easy installation, easy connecting, rugged construction, low noise level.

### TYPICAL APPLICATIONS

Sorgel Air-Cooled Dry-Type Transformers are used to:

- Operate 120 volt lighting and portable equipment from 240, 480 or 600 volt power circuits.
- Supply more than one voltage from a single voltage system.
- Change odd voltages to standard voltage.
- Phase changing.
- For high voltage interior distribution systems of 2400, 4160, 4800, 7200, 13,200 and up to 15,000 volts.
- For substations and load centers.

*Tested and approved by Underwriters' Laboratories  
under the Re-examination Service*

### Complete line

1/4 Kva to 2500 Kva single phase.  
1 Kva to 3000 Kva 3-phase, 2-phase,  
and phase changing.

All standard voltages, such as 120,  
208, 240, 480, 600, 2400, 4160,  
4800, 7200, 13,200, and up to  
15,000 volts, and any intermediate  
or special lower voltage.

### Stock carried by jobbers in the following cities:

Milwaukee, Wis.	Cincinnati, Ohio
Chicago, Ill.	Cleveland, Ohio
Rockford, Ill.	Louisville, Ky.
Rock Island, Ill.	Omaha, Neb.
Richmond, Ind.	Davenport, Iowa
New York, N.Y.	Cedar Rapids, Iowa
Buffalo, N.Y.	Beaumont, Tex.
Roxbury, Mass.	Los Angeles, Calif.

**Also Special Transformers  
and Saturable Reactors**

Consult the classified section  
of your phone directory, or  
write to the factory

*Sales Engineers in Principal Cities*

**SORGEL ELECTRIC CO., 836 West National Ave., Milwaukee 4, Wisconsin**

*40 years' experience in the development, manufacturing and application of transformers*

# Solve Distribution Problems with SORGEL Substations

**"Packaged" Units for Indoor Installations**

**Speeds Expansion and Earlier Production.** The Substation is shipped complete in one or more factory-assembled units, on a substantial steel base, completely wired and tested, ready for installation and final connection. This saves the extra expense of buying separately the transformers, switches, fuses, insulators, circuit breakers, and other accessories; thereby also saving the extra labor cost and trouble when assembling and connecting on the job.

**Flexibility for Future Conditions.** Being all self-contained in a single unit, the Substation can be readily moved from one location to another.

**Saves Copper.** The Substation can be placed near the load center, so that shorter secondary cables and smaller primary lines can be used. Improved voltage regulation and reduced line drop.

**Reduces Costly Power Interruption.** By locating the Substation at or near the load center, it restricts the power interruption to that area. Other areas, not affected, can continue operation.

**Years of Continuous Hard Service.** The rugged construction, liberal design, expert craftsmanship, sound engineering, all embodied in SORGEL transformers, have given years of continuous severe service.

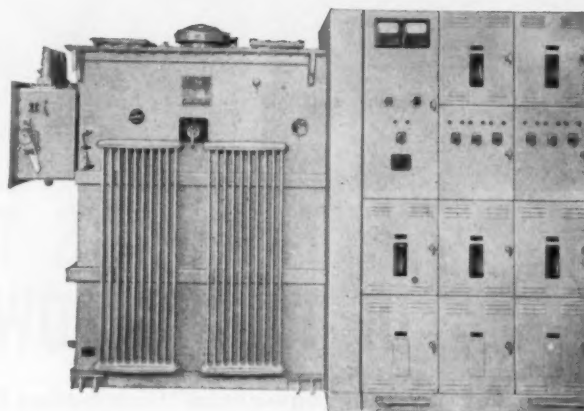
**Types.** Either dry-type or Askarel-cooled transformers are available with any type or make of switchgear, or from any substation manufacturer.

## Engineered to meet your exact requirements

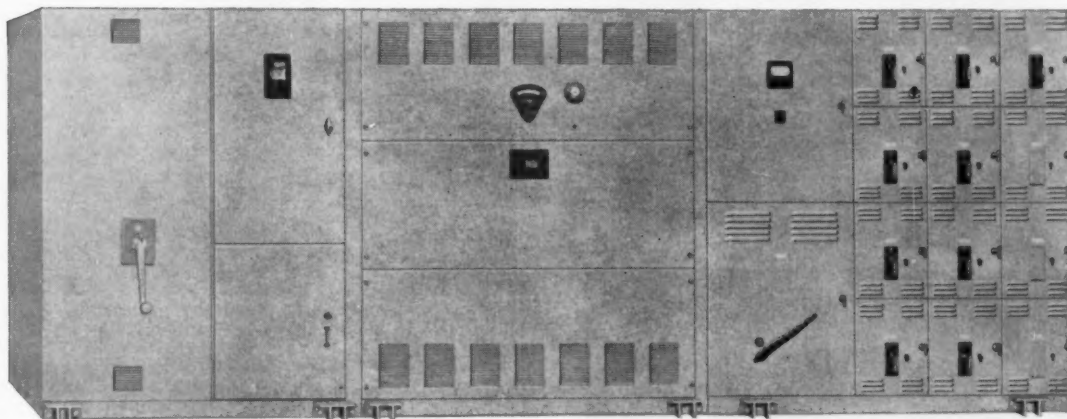
Not necessary to design or change  
your installation to fit a "standard"

**Sizes up to 3000 Kva.  
All voltages up to 15 KV.**

SORGEL transformers are particularly adaptable for indoor installations; in hospitals, libraries, schools, institutions, office buildings, and other structures where low noise levels are an important factor.



500 Kva, 13,800 volt Askarel-cooled SORGEL transformer, with primary liquid filled switch, secondary meters, and circuit breakers.



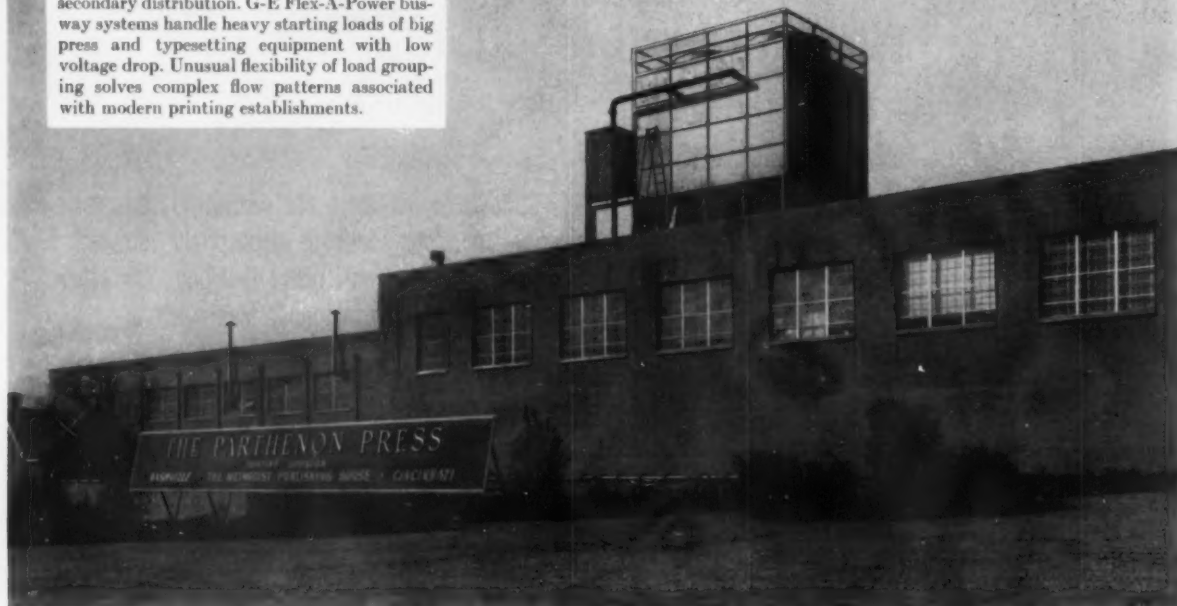
2000 Kva 3-phase, 13,200 volts air cooled dry-type transformer, with primary switchgear, metering, and secondary breakers.

*Sales Engineers in Principal Cities*

**SORGEL ELECTRIC CO., 836 West National Ave., Milwaukee 4, Wisconsin**

*40 years' experience in the development, manufacturing and application of transformers*

Famous Parthenon Press, printing division of Methodist Publishing House, Nashville, Tenn., is equipped with G-E "System Engineered" secondary distribution. G-E Flex-A-Power busway systems handle heavy starting loads of big press and typesetting equipment with low voltage drop. Unusual flexibility of load grouping solves complex flow patterns associated with modern printing establishments.



## 7 EXTRA WAYS TO KEEP AHEAD OF RISING POWER DEMANDS

**G-E "System Engineered" Distribution Equipment is Designed to Help Meet 1965's Expected 2-Fold Increase in Your Plant Power Consumption**

G-E "System Engineered" secondary distribution equipment—illustrated on these pages—is *engineered to work together as an integrated system*. It can be expanded to handle future loads or relocated to suit altered production lines. G-E design gives you maximum safety, reserve power handling capacity and low initial installation and relocation costs.

Look over these important EXTRA ADVANTAGES you get with G-E "System Engineered" secondary distribution:

**1. True Extendability** because G-E standardized components are compact and accessible... especially designed for easy addition or relocation.

**2. Easy-to-assemble.** Flex-A-Power\* Busways, for example, quickly bolt together, reduce labor and maintenance costs.

**3. No loss when moving** and reinstalling distribution equipment. "System Engineering" provides for practically 100% re-use of materials.

**4. Complete relocation of loads** without rewiring with G-E Flex-A-Power plug-in distribution Busways.

**5. Maximum electrical efficiency** and minimum maintenance from components engineered to work together.

**6. One source of supply** for all components ends procurement problems and reduces costs.

**7. Skilled planning service** from G-E Engineer who is not just selling components but, instead, electric distribution systems to make sure your installation has a built-in future.



View of G-E Type LVD Feeder Busways leaving G-E circuit breaker switchboard at Parthenon Press. Matching components from one source eliminate many design problems.

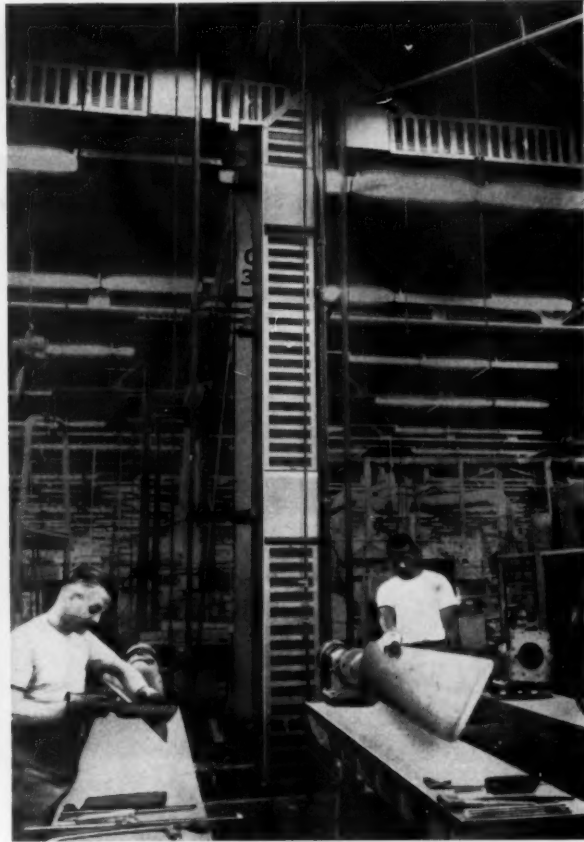
Ask your nearest Electrical Contractor, G-E Distributor or Representative for full information. Or write—General Electric Company, Distribution Assemblies Department, Plainville, Connecticut.

Architects & Engineers—Hart, Freeland & Roberts, Nashville  
Electrical Contractor—Stansell Electric Co., Nashville  
Distributor—G.E. Supply Co., Nashville

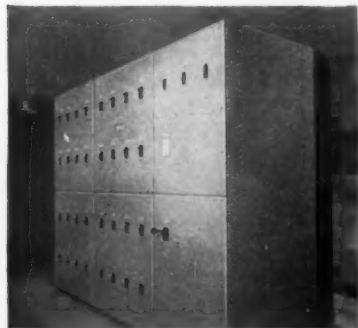




**Control Center**—New G-E Type DA7093 Motor Control Center, with capacity to interrupt 50,000 amperes, occupies 50% less floor space than comparable equipment. Standardized, self-supporting, 90-inch-high vertical sections are connected by common power bus and will accommodate nine NEMA Size 1 units or six Size 2 units.



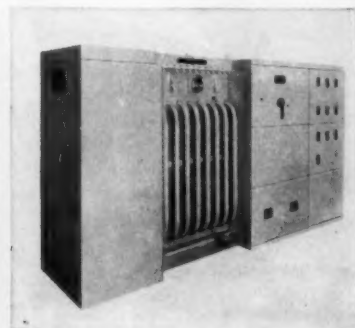
**Busways**—Flex-A-Power\* Busways, with either copper or aluminum busbars, are erected easily with "building block" sections of standard lengths. Housings exclude dirt and dust and protect personnel, yet permit outlets for most concentrated load groupings. Prefabricated fittings make assembly rapid and keep installation costs at a minimum.



**Switchboards**—Completely wired at factory. Large air or molded case circuit breakers, fusible switch units, meters, instruments, and accessories already installed on switchboards.



**Panelboards**—Types NAB, NHB, NLAB, NLTQ, NLTQX, NTP, NTC for lighting—types NCB, CCB, Swing-WA\* and Converte-Fuse\* for power distribution. Full line. Factory assembled.



**Sectional Distribution Centers**—Factory assembled to reduce installation cost. Short secondary feeders in load-center system mean low voltage drop. Easy-to-order arrangement ends costly detailing.

\*Registered Trade-mark of General Electric Company

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

The Dual-Element Fuse That's Different

# ECON\*

## Dual-Element Cartridge FUSES

\*Trade Mark Reg.

... carry their own  
**"STOP WATCH"**

You get extra protection against overloads and "shorts" with ECON Dual-Element Cartridge Fuses.

Because on a sustained overload, heat from the fusible links is conducted into the Econ-alloy time-lag element. If the overload is continued *beyond the safe and predetermined time*, the heat causes the Econ-alloy to become liquid and release from the fusible links, thereby opening the circuit.

On a short circuit, the fusible links open the circuit immediately before dangerous pressures can be developed.

ECON Dual-Element Cartridge Fuses are available in knife and ferrule types; 0 to 600 amperes; 250 and 600 Volts. Underwriters' Laboratories, Inc. Approved. Carried in stock by leading Electrical Wholesalers. Write for New ECON Catalog S-60 or for literature on other type fuses in which you are interested.

☆ ☆ ☆

Your Electrical Wholesaler has ECON  
Dual-Element Cartridge Fuses in stock

### ECONOMY

fuses for every purpose

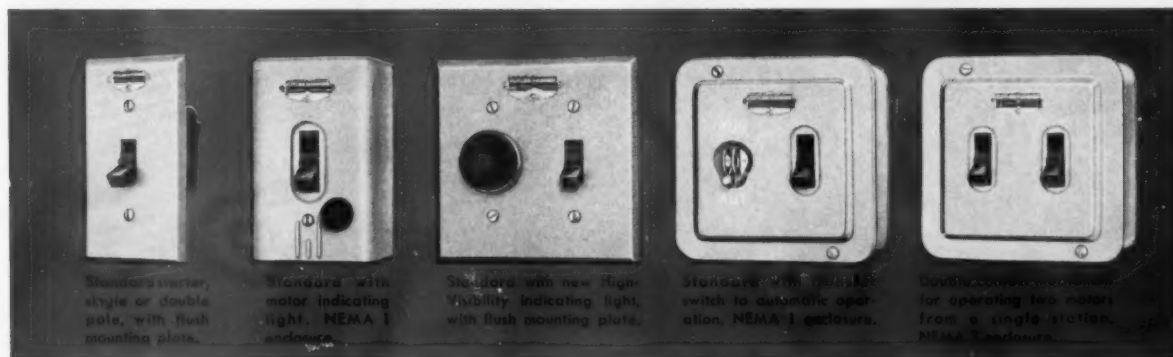
#### ECONOMY FUSE & MANUFACTURING CO.

2717 GREENVIEW AVE.

CHICAGO 14, ILLINOIS

# Now—the 9101 "Family"

The Cutler-Hammer Line of  
fractional horsepower manual starters now includes  
new mechanisms, new styling, new uses

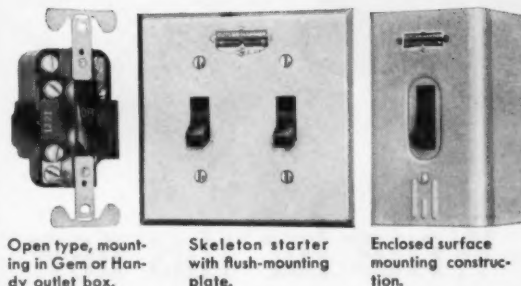


In order to meet the ever-growing needs of the market with a starter of proven design, Cutler-Hammer now brings out a complete family of Bulletin 9101 Manual Starters for fractional horsepower motors.

This family now includes the standard starter with motor-running indicating light, with standard or with high-visibility lenses. It now includes a standard switch together with transfer switch to automatic operation with padlocking provision. It now includes a "2 in one" model, two starters in one case for controlling 2 motors from a single station.

Another feature of great interest is the optional brushed stainless steel flush plate for installations such as hospitals, modern office buildings, etc. Conventional finish is gray baked enamel on a bonderized undercoat.

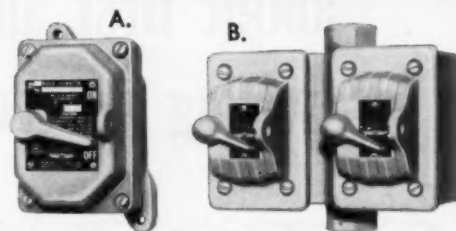
9101 starters are available for mounting in a standard Gem or Handy outlet box; for flush mounting; for surface mounting. The 9101 is a high-quality line at no premium cost. Its features include single or double pole, quick make and break silver contacts; eutectic alloy overload protection; straight-through wiring; wrap around covers, etc., etc. Available at your authorized Cutler-Hammer distributor. CUTLER-HAMMER, Inc., 1306 St. Paul Ave., Milwaukee 1, Wis. Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ont.



Open type, mounting in Gem or Handy outlet box.

Skeleton starter with flush-mounting plate.

Enclosed surface mounting construction.



A. Starter in NEMA 7 or 9 Special Service Enclosures.

B. Duplex starter in NEMA 4 or 5 Special Service Enclosure.



**THE "PLUS FACTOR" FOR EFFICIENT ELECTRICAL INSTALLATIONS**

**1 HOT GALVANIZED:** The specially selected pipe for this conduit is first thoroughly cleaned by pickling and then immersed in a bath of molten pure zinc. After removal from this bath by a special process which leaves a clean, smooth coating of zinc on both the outside and inside of the pipe, the pipe is accurately threaded. A coating of tough transparent enamel is laid on both the outside and inside of the conduit, providing a smooth raceway through which wires may be readily fished.

**2 ELECTRO GALVANIZED:** The pipe after being threaded, cleaned and carefully inspected is again thoroughly cleaned before galvanizing. The galvanizing equipment is so devised and arranged that the interior from one end to the other, tests are continuously made to insure proper weight of coating. A coat of tough, smooth and elastic black enamel is then laid on the interior.

**3 BLACK ENAMELED:** After dipping in the enamel, the conduit is allowed to set to insure uniform thickness of the coating and to prevent wrinkling. The loaded cages of pipe are then placed in baking ovens where an even temperature is accurately maintained by pyrometers. The enamel is baked to a high lustrous finish, having a thorough tight coat with proper elasticity to guard against cracking in any situation.

**4 ELECTRICAL METALLIC TUBING:** The exterior is given a uniform protective coating of pure zinc by the electro-galvanic process. This coating will withstand bending without fracturing. On the inside is baked a tough, elastic coating of enamel which serves both as a minor raceway through which wires are usually fished and as an added protection for the wiring system.

**4 WAYS TO GREATER EFFICIENCY & LOWER INSTALLATION COSTS**

WITH YOUNGSTOWN BUCKEYE CONDUIT  
1 HOT GALVANIZED  
2 ELECTRO GALVANIZED  
3 BLACK ENAMELED  
4 ELECTRICAL METALLIC TUBING

THE YOUNGSTOWN SHEET AND TUBE COMPANY  
AN IRON PIG COMPANY  
YOUNGSTOWN, OHIO

**YOUNGSTOWN BUCKEYE CONDUIT**

Write for this new folder  
about first aid  
for wiring protection

**Youngstown**

**BUCKEYE CONDUIT**



**THE YOUNGSTOWN SHEET AND TUBE COMPANY**

General Offices: Youngstown, Ohio - District Sales Offices in Principal Cities

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT  
AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - BAR SHAPES - WIRE  
HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - RAILROAD TRACK SPIKES

●Youngstown Buckeye Conduit is full-weight rigid steel and is manufactured as Hot Galvanized, Electro-Galvanized and Black Enameled. It is available for immediate delivery in sizes from half inch up to six inches. We can also furnish Electrical Metallic Tubing in sizes from half inch up to two inches.

"4 Ways to Greater Efficiency, Lower Installation Costs" is a new folder giving a full description of each type, with complete information as to wall thicknesses, fittings, etc. Copies are available at no charge to guide you and your customers in the selection of steel conduit. Write for as many as you can use.

Rigid steel conduit is the **SAFE** raceway approved by the National Electrical Code for all hazardous locations. To be **ENTIRELY SAFE** use the best, use Youngstown Buckeye Conduit, your first aid for wiring protection.

Manufacturers of  
Carbon, Alloy and Voley Steel



# YOUNGSTOWN BUCKEYE CONDUIT



## HOT GALVANIZED:

High quality steel pipe is first thoroughly cleaned by pickling in acid, then immersed in a bath of molten pure zinc. After threading, a coating of tough, transparent enamel is baked on—providing double corrosion protection of zinc and enamel—inside and out.



## ELECTRO GALVANIZED:

After being threaded, reamed and carefully inspected, this conduit is cleaned by pickling, then uniformly coated outside with zinc. A coat of tough, elastic black enamel is then baked on the interior, providing protection as well as a smooth raceway for trouble-free wire pulling.



## BLACK ENAMELED:

A protection, black enamel coating is applied inside and out by dipping. When a uniform thickness of this coating has been achieved, it is then baked to form a tight, elastic, high lustre finish—guarding against cracking in bending or forming operations during installation.



## ELECTRICAL METALLIC TUBING:

Absolute uniformity of weight, wall thickness and concentricity, plus protective outside coating of pure zinc and baked-on elastic enamel interior, forms this modern mirror-smooth raceway. Lightweight, easy to handle, no threads to cut, bends readily and assures safe, economical, life-time electrical installations.

*Proven -  
THROUGH THE YEARS*

Yes, Youngstown Buckeye Conduit has been proven through the years by thousands of owners and by leading Electrical Contractors the world over . . . proven that it is easy to bend . . . easy to fish wires through . . . and economical due to greater corrosion resistance that means longer, trouble-free life in actual service. Youngstown Buckeye Conduit has also proven that it pays dividends through lower installation costs and greater efficiency. Add to these many features the fact that Youngstown Buckeye Conduit is manufactured "from iron ore to the finished product" by ONE integrated steel company and you know why it is preferred by so many.

## CONDUIT

Size	Nominal Diameter (Inches)		Nominal Wall Thickness (Inches)	Threads Per Inch	Feet Per Bundle
	Internal	External			
1/2	.622	.840	.109	14	100
3/4	.824	1.050	.113	14	50
1	1.049	1.315	.133	11 1/2	50
1 1/4	1.380	1.660	.140	11 1/2	30
1 1/2	1.610	1.900	.145	11 1/2	30
2	2.067	2.375	.154	11 1/2	
2 1/2	2.469	2.875	.203	8	
3	3.068	3.500	.216	8	
3 1/2	3.548	4.000	.226	8	
4	4.026	4.500	.237	8	
5	5.047	5.563	.258	8	
6	6.065	6.625	.280	8	

Conduit furnished in 10-foot lengths, threaded both ends with one coupling.

## COUPLINGS

Size	Outside Diameter (Inches)	Length (Inches)	Pieces Per Carton
1/2	1.063	1.562	100
3/4	1.313	1.625	50
1	1.576	2.000	50
1 1/4	1.900	2.062	50
1 1/2	2.200	2.062	50
2	2.750	2.125	25
2 1/2	3.250	3.125	
3	4.000	3.250	
3 1/2	4.625	3.375	
4	5.000	3.500	
5	6.296	3.750	
6	7.390	4.000	

## ELBOWS

Size	Radius (Inches)	Offset (Inches)	Pieces Per Carton
1/2	4.000	6.500	50
3/4	4.500	7.250	50
1	5.750	8.750	25
1 1/4	7.250	10.500	20
1 1/2	8.250	11.750	15
2	9.500	13.500	10
2 1/2	10.500	15.000	
3	13.000	18.000	
3 1/2	15.000	20.500	
4	16.000	22.000	
5	24.000	31.000	
6	30.000	37.500	

## ELECTRICAL METALLIC TUBING

Size	Nominal Diameter (Inches)		Nominal Wall Thickness (Inches)	Feet Per Bundle
	Internal	External		
1/2	.622	.706	.042	100
3/4	.824	.922	.049	100
1	1.049	1.163	.057	100
1 1/4	1.380	1.510	.065	50
1 1/2	1.610	1.740	.065	50
2	2.067	2.197	.065	30

EMT furnished in 10-foot lengths, without couplings.

**THE YOUNGSTOWN SHEET AND TUBE COMPANY**

GENERAL OFFICES • YOUNGSTOWN 1, OHIO • U. S. A.



# new lighting solutions from ELECTRO SILV-A-KING

## MODULAR SQUARES

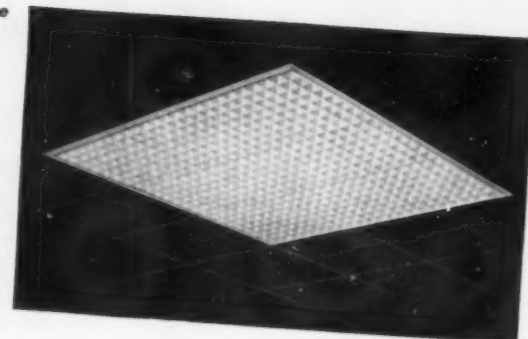
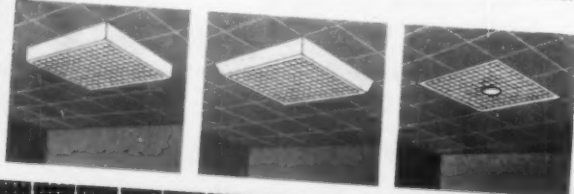
**PROBLEM** How to create larger light source areas more economically . . . and how to utilize the same basic fixture throughout the installation.

## BAYLITE

. . . in modular squares from 2' x 2' to 5' x 5' for surface or recessed mounting, slimline or fluorescent.

Lighting patterns take on new flexibility with versatile BAYLITES. They can be used individually, in continuous runs, or grouped to create a "louver-all" appearance for large light source areas with a minimum number of fixtures.

BAYLITE units can be recessed or surface mounted . . . and the extremely wide range of possible light intensities allow their use throughout an entire installation so as to achieve a pleasing, uniform effect.



ELECTRO SILV-A-KING BAYLITES are available in several models or to your specifications.

- 2' x 2', 2' x 4', 4' x 4', 5' x 5'
- Four, Six, Eight or Ten Lamps • Metal sides or skirts
- Gimbal Ring spots available for PAR-38 lamp
- 35° x 35° shielding - with standard metal louver (Plastic available)
- Rapid Start • Standard Fluorescent • Slimline

## TM TROFFER SERIES

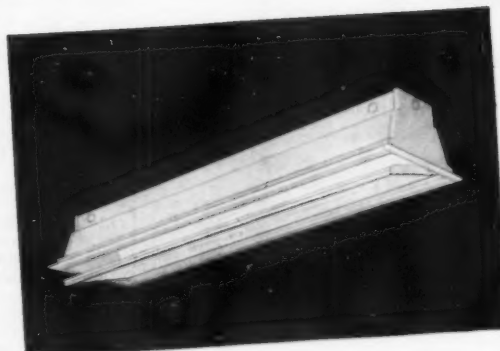
**PROBLEM** How to improve the aesthetic qualities of Troffer lighting with a reduction in installation and servicing costs.

Exclusive

## magic frame

**TROFFERS** . . . eliminate all exposed, unsightly door screws and latches. Exclusive simplified installation provides "Speedy Latches" in wireway channel for efficient and simple hanging. All electrical components are contained on a removable chained cover.

"MAGIC FRAME" Troffers have no unsightly protuberances to disturb the trim lines of the fixture. Doors lock by gravity, hinge on two concealed pivots for quick maintenance. Completely removable by merely lifting and shifting. For installation, maintenance or removal of the door, there are no screws to loosen, remove or lose . . . doors are interchangeable into any like



Magic Frame fixture.

"Magic Frame" Troffers are available with all types of flat glass and plastic diffusers such as: ALBA-LITE, FOTA-LITE, CRYSTAL-LITE, TWINLENS, P4 DIAMOND, PATTERN PLEXIGLAS. 2-ft., 4-ft., 5-ft., 8-ft., lengths. Rapid Start • Standard Fluorescent • Slimline.

Write for the name of the ELECTRO SILV-A-KING district manager near you . . . and new Specification Data Catalog.

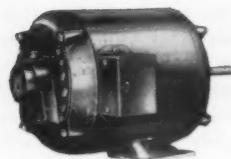
## ELECTRO SILV-A-KING CORPORATION

1535 S. Paulina Street, Chicago 8, Ill. • Spruce and Water Streets, Reading, Pa.

# GET TOP PERFORMANCE FROM YOUR EQUIPMENT . . .

Choose *Century*  
From the Wide  
Range of Types of **MOTORS**

in Sizes From 1/8 to  
400 Horsepower



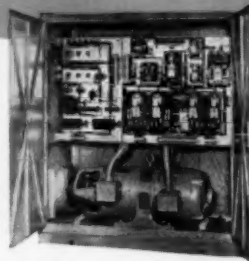
## SINGLE PHASE:

Split Phase Induction— $\frac{1}{8}$ ,  $\frac{1}{4}$ ,  $\frac{1}{2}$  H. P.

Capacitor— $\frac{1}{8}$  to 20 H. P.  
Repulsion start, brush lifting,  
induction— $\frac{1}{2}$  to  $7\frac{1}{2}$  H. P.

Write for Bulletin Nos.:

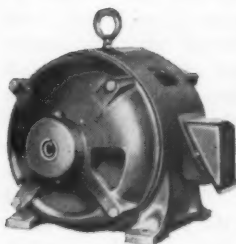
Split Phase . . . . . 1-5P1  
Capacitor . . . . . 1-1P3  
Repulsion Start . . . . . 2-1P1



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A complete line of adjustable  
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## POLYPHASE:

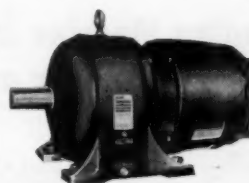
Squirrel Cage Induction—  
 $\frac{1}{8}$  to 400 H. P.

Wound Rotor Motors—1 to 400 H. P.

Synchronous Motors—20 to 150 H. P.

Write for Bulletin Nos.:

Squirrel Cage, Drip Proof—6-1P1  
Squirrel Cage, Splash Proof—6-1P3  
Squirrel Cage, Enclosed Fan Cooled—6-1P41  
Squirrel Cage, Explosion Proof—6-1P45  
Wound Rotor—6-3P1



## GEAR MOTORS:

$\frac{1}{8}$  to 15 H. P., single, double and  
triple gear reduction.

Write for Bulletin Nos.:

$\frac{1}{8}$  to  $\frac{3}{4}$  H. P. . . 4-5P21-61  
1 to 15 H. P. . . 4-1P31



## DIRECT CURRENT:

All capacities— $\frac{1}{8}$  to 300 H. P.

Write for Bulletin No. 10-1P1



## GENERATORS:

AC, .63 to 250 KVA

DC, .75 to 200 KW

Write for Bulletin Nos.:

AC, .63 to 250 KVA—18-1P21  
DC, .75 to 200 KW—18-1P1

CE-825R

Motors listed above are available in Open  
Rated Drip Proof, Splash Proof, Totally  
Enclosed Fan Cooled and Explosion Proof  
frames—and with a dozen different methods of  
mounting. They are unusually quiet starting  
and running and unusually free from vibration.



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1806 Pine Street, St. Louis 3, Missouri  
Offices and Stock Points in Principal Cities

## Send the Coupon for Additional Facts

To CENTURY ELECTRIC COMPANY  
1806 Pine Street, St. Louis 3, Mo.

Please send me the following bulletins:

(All in numbers here)

Name.....Title.....  
Company.....  
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## Why this new **RIDGID 500A**

**Pipe & Bolt Threading Machine is making sales records for fast turnover and profit**

**Works like a Charm**—new type Speed Chuck means fast chucking—guaranteed to hold any pipe, conduit or rod tight, forward and reverse! Jaws close and open easily by hand wheel . . . Cutting, threading, reaming tools operate independently, swing up out of way—short pipe can be chucked from front. Quick-opening Quadri, Dual, Mono and Bolt die heads quickly in and out, adjust to size right in machine.

**Built like a Machine Tool**—Last word in efficient design, easy operation, long service. Plenty of power. Capacity  $\frac{1}{8}$ " to 2" pipe and conduit;  $\frac{1}{4}$ " to 2" bolts—to 12" pipe with geared tools.

**500A is pre-sold by national advertising to your customers. Write for the facts today!**

**THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U.S.A.**



### 11.0 Residential

Service entrance conductors shall be

a. Service entrance cable (SE).

b. Armored service entrance cable (ASE)

c. Installed in — inch conduit

d. Underground service entrance cable (USE)

in accordance with the rules and requirements of applicable codes and the rules of the utility company supplying the property.

### 11.11 Underground.

From a point on the utility pole 4 in. above the upper conductor of the distribution lines adding 30 in. for drip loops and connections, provide a USE cable of the size specified to the service terminals of the service switch (meter box, service panel, etc.).

From a point on the pole 8 feet above grade provide a run of — inch rigid conduit down below grade with an elbow terminating at the level of the underground run. Provide insulating bushings at each end of the protective conduit run. The conduit shall be firmly attached to the pole with at least two approved pipe straps.

Cable for the run up the pole shall be neatly coiled above the protective conduit for installation and connection by the utility. The utility will install the cable on the pole, seal the upper entrance to the protective conduit, enclose the cable in wood molding and make final connection to the distribution conductors.

a. Cable shall be buried to a depth of 30 in. (or below frost line). Where cable passes under driveways it shall be covered by 6- by 2-in. creosoted wood planking to a distance of 3 ft beyond each side of the driveway.

At the building end of the underground run the cable shall be enclosed in rigid conduit to a distance of 5 ft from the wall.

Where the cable enters the conduit at each end of the underground run the conduit shall be sealed with oakum and sealing compound. The seals shall be surrounded by 6 in. of sand in all directions before back filling.

b. Extend the service conductor in rigid conduit underground at a depth of — inches.

c. Extend the service conductor in approved (fiber, Transite, etc.) conduit underground from the pole to the building.

*More Specifications on Page 222*



After TWO years of field-testing, here's the

# NEW IMPROVED TIREX CORD

- *It's more flexible than ever before!*
- *It has greater pliability when cold!*
- *It's much easier and faster to machine-strip!*

New TIREX CORD retains its Selenium Neoprene Armor for added toughness.

New TIREX CORD is still cured in lead to make it smoother, denser and more uniform.

**The New TIREX is the most supple, limber TIREX Cord ever made!**

Find out more about the New TIREX CORD. Write to the address below for Folder 1022 today.

**Simplex**  
TIREX

**SIMPLEX WIRE & CABLE CO., 79 Sidney St., Cambridge 39, Mass.**

## ELECTRICALLY SAFE MODEL HOMES SPECIFY

# NO-SHOK

### SAFETY ELECTRIC OUTLETS

The built-in extra safety of NO-SHOK Outlets gives your homes an extra selling point! Patented safety cap automatically prevents insertion of hairpins, wires, or other metal objects . . . protects children against tragic accidents. Install NO-SHOK — a "must" for every safety-conscious home buyer.

**SELF-CLOSING OUTLET . . .  
positively prevents SHOCKS  
BURNS . . . SHORT CIRCUITS**

INSERT PLUG, MAKE QUARTER-TURN TO RIGHT, PUSH IN to make contact with current. Cap automatically snaps shut when plug is removed.



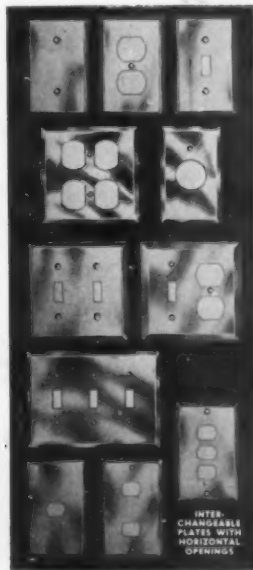
### INSTALLED IN . . .

- ★ "Home of Safety"  
Cleveland, Ohio
- ★ "Research House, 1954"  
(Associated Architectural Publications)
- ★ House & Garden  
"Fourth House of Ideas"



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## De Luxe METAL WALL PLATES



America's handsomest selection — unmatched for styling and quality! BELL De Luxe Metal Wall Plates beautify new homes . . . modernize older homes . . . harmonize with every interior. Durable made of top-quality materials in a full line of styles and sizes to fit every need.

### 6 EXCITING NEW FINISHES!

- De Luxe Lifetime CHROME
- Brown or Ivory PAINTED CRACKLE
- New ANTIQUE FINISHES—  
GOLD, SILVER, COPPER and  
BLACK WROUGHT IRON
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On every installation, specify BELL De Luxe Metal Wall Plates for maximum quality and appearance!

WRITE TODAY FOR FULL DETAILS AND PRICES: Dept. EG

## BELL ELECTRIC COMPANY

1844 West 21st Street • Chicago 8, Illinois

## 11.0 Residential

### 11.2 Panels

Panelboards are usually chosen from among many specially designed for residential service. The main switch and branch circuits may be enclosed within the same box. Some types take advantage of the "six circuit rule" and parallel the main, range and dryer units.

The Code permits up to six circuits to be served directly from the service entrance conductors. Multiple mains can be conveniently arranged to serve heavy duty appliance circuits, such as the range, dryer and water heater, and feeders to branch circuit distribution panels.

Branch circuit distribution may be incorporated in the service entrance panel enclosure, or in separate panels located at load centers and served by feeders from one or more of the mains.

Typical equipments provide for up to six double-pole fused switches or circuit breakers (or 12 single poles operable by six handles) on a main bus. A separate bus with a group of branch circuits in the same enclosure is fed from one of the mains.

Most residential wiring systems use a single panelboard. There is a trend, however, toward dividing the circuits among one or more additional panels which can be located advantageously near load centers.

When power centers are located flush in living areas it is important that provisions be made for access to the spares for future use. A 1-in. empty conduit, tubing or flex is extended to the basement or attic terminating in a 4-11/16-in. box with blank cover.

The main service switch or panel must be located within three feet of the entrance of the service conductors. Additional panels may be located wherever convenience may indicate.

#### 11.21 Service switch.

(Where separate service switch is installed, if no separate switch is installed see main panel below.) Furnish and install where shown on plans a main service entrance switch approved for use on service entrance equipment. Switch shall be — pole — amp (fused or circuit breaker) with neutral bus.

#### 11.22 Main panel.

Furnish and install where shown on  
More Specifications on Page 224

# Wanted: Dealers, Electrical Contractors to sell new Exide®-Lightguard®

Profits unlimited, tremendous sales potential. There are hundreds of money-making opportunities all around you to sell Exide Lightguard emergency lighting protection! Everywhere people gather there is a possible sale for Exide Lightguards. Send coupon now for full details.

## YOU CAN CASH IN AS A DEALER

Power interruptions can happen anywhere, anytime, despite every precaution taken by utility companies. Every public gathering place needs emergency lighting—needs the protection of Exide Lightguard: Factories, Schools, Hospitals, Theaters, Restaurants, Hotels, Stores and Markets, Banks, Police Stations. *And as many as 200 Exide Lightguard units are deemed necessary by some industrial plants!*

YOU can quickly build extra profits for yourself.

Emergency lighting protection is now required by law in many cities and states—another reason Exide Lightguard units offer good sales opportunities for electrical dealers and contractors. Write for full details—the Exide Lightguard unit has many other easy-to-sell user benefits!

### Here are money-making spots in your community:

SCHOOLS • HOSPITALS • HOTELS • CHAIN AND  
DEPARTMENT STORES • INDUSTRIAL PLANTS •  
RESTAURANTS • APARTMENTS • BANKS • CHURCHES  
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LIBRARIES • OFFICE BUILDINGS • POLICE STATIONS

### Lighting protection is needed for:

sales floors • open counter displays • cashier's cages  
• corridors • aisles • dining rooms • lobbies • boiler  
rooms • engine rooms • switchboard rooms • machine  
shops • payroll departments • loading platforms  
• bank vaults • auditoriums • exits • medicine  
rooms • firetowers • stairways • swimming pools •  
locker rooms • court rooms



Model M, double lamp unit

## THE ONLY COMPLETELY AUTOMATIC EMERGENCY LIGHTING UNIT ON THE MARKET!

It operates instantly and automatically on any interruption to the normal A.C. power supply. Provision is made so that it automatically recharges itself upon restoration of normal power.

MAIL THIS COUPON NOW!

## Exide INDUSTRIAL DIVISION

The Electric Storage Battery Company  
Philadelphia 2, Pa.

Send me all the facts. I want to cash in on emergency lighting. Rush specifications, wiring systems, sales information on NEW EXIDE LIGHTGUARD UNITS.

NAME \_\_\_\_\_

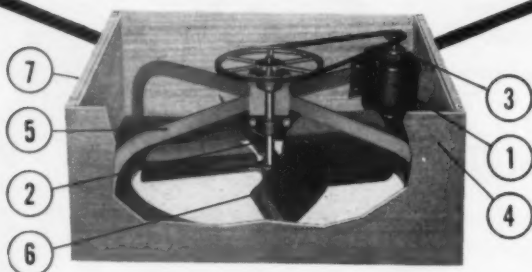
ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

My business is: ☐ Electrical Contractor; ☐ Consulting Engineer; ☐ Architect; ☐ Distributor; ☐ Dealer; ☐ Electrical Engineer; ☐ Other

When you want maximum efficiency  
and economy in home cooling—

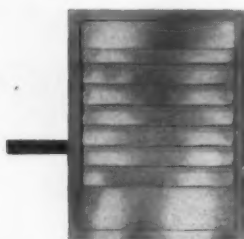
## Get the "INSIDE" STORY on **Air King** ATTIC FANS



### HORIZONTAL MOUNTED CEILING FAN

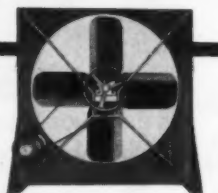
Here's the one attic fan you install — and forget! It's designed and built to operate efficiently — cool an entire house easily and quickly — with an absolute minimum of attention. Available in 5 sizes from 24" to 42" delivering 5500 CFM to 12,800 CFM. The ideal way to low cost "air conditioning" for one house or one thousand!

1. Motor is Thermaguard protected, Resilient Mounted, with Sealed Lubrication Ball Bearings. It won't short or burn out . . . absorbs vibration . . . requires no attention . . . insures smoother operation.
2. Shaft Mounted on Sealed-for-Life Ball Bearings set in solid rubber. Never requires lubrication, eliminates noise and vibration.
3. Handy box on motor for quick wiring — just bring BX or wire to box and hook. No need to remove motor.
4. Installs right in its own "Built-In" Frame. Saves time and materials.
5. Heavy Gauge Steel Construction Throughout.
6. Individually Weighed and Balanced Blades. Reduces motor strain and insures vibration-free operation.
7. Requires Minimum of Roof Clearance.



**Horizontal Mounted Ceiling Fan LOUVERS**

Rectangularly shaped Louvers permit the fan to be installed through the louver opening. Completely finished with chrome plated screws, no additional trim necessary. In air or electric motor operated models with handsome Ivory finish. Louvers also available for Vertically Mounted Attic Fans. In air and electric motor operated models.



**Vertically Mounted Attic Fans**

Ruggedly constructed with fan bracket of heavy gauge bar stock. Heavy duty motor and provision for manual adjustment of belt tension. A truly low cost method for cooling an entire house. In sizes ranging from 24" to 48" delivering 5,500 CFM to 18,000 CFM.

Send Today for complete Berns Air King Attic Fan Catalog

**BERNS MANUFACTURING CORP.**

Dept. EA, 3050 No. Rockwell St., Chicago 18, Ill.

## 11.0 Residential

the plans a service entrance panel. The panel shall be equipped with — ampere mains and the following circuits. (List circuits and describe connection of main disconnects if more than one)

Panel shall be dead front type with overcurrent protection provided by

a. fuses

b. circuit breakers, (thermal, thermal magnetic, hydraulic magnetic)

(When panel is a service entrance panel) The main panel shall be approved for use as service entrance equipment.

From the entrance panel provide feeder(s) of 3 No. — conductors to the mains of the load center(s) as shown.

### 11.3 Wiring System

In single-family residences the method of wiring is usually determined by local ordinances or historical practice in the community. For multi-family dwellings, flats, and apartment houses, the wiring system employed usually follows commercial and institutional practice. The following specification is intended to apply to single-family dwellings or multi-family dwellings of similar construction and electrical consideration.

The six wiring systems most widely used in residential work are:

Knob and tube

Non-metallic sheath cable

Armored cable

Flexible conduit and wire

EMT and wire

Rigid conduit and wire

Combinations of methods are sometimes used as rigid conduit service and cable branch circuits or EMT on exposed work and armored cable concealed. All are approved by the National Electrical Code. Local ordinances in some communities may omit or restrict the use of some.

Wiring shall be — (specify wiring system) installed in accordance with the installation rules of the National Electrical Code and local rules and ordinances which apply. Wiring shall be installed firm and true, in an expert manner mechanically and electrically. Cutting and drilling of structural members shall be limited to that essential for proper installation.

Grounding conductor (on knob and tube or non-metallic sheath cable  
More Specifications on Page 226



# WIRING DEVICE PYLETS<sup>®</sup>

## Save TIME and MONEY

Large wiring space in these PYLETS accommodates standard wiring devices of the flush mounting type.

A wide choice of interchangeable covers simplifies and reduces cost of changes in outlets and control stations.

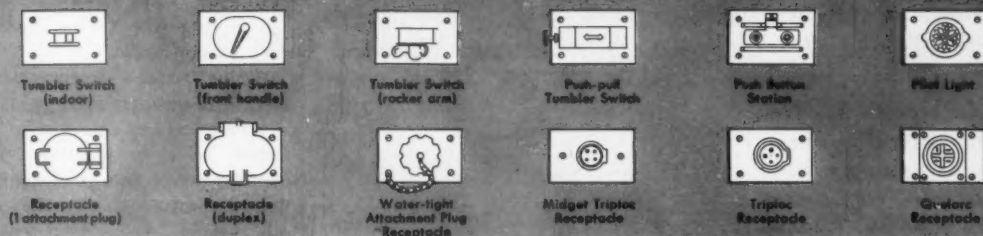
Cast metal construction, with heavy cadmium plated finish, protects devices for long trouble-free service...reduces maintenance cost, replacement cost and shut-down time.

Adaptability of the PYLET body to so many types of circuit controls and service outlets permits substantial reduction in inventory and stocking costs.



### FS and FD SERIES FOR ORDINARY LOCATIONS

Water-Tight, Vapor-Tight and General Duty Types Available

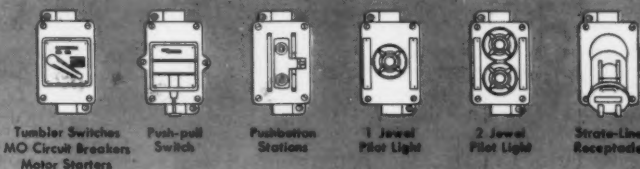


### ER SERIES FOR HAZARDOUS LOCATIONS

Explosion-Proof and Dust-Tight

Explosion-proof wiring device PYLETS are made in 1 and 2-gang combinations in shallow and deep types. They are supplied complete with cover and wiring device.

*Literature Furnished on Request*



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District Offices and Representatives in Principal Cities of the United States. CANADIAN AGENT: The Holden Co., Ltd., Montreal  
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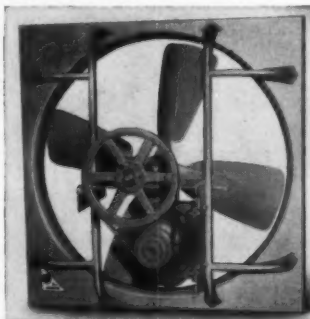
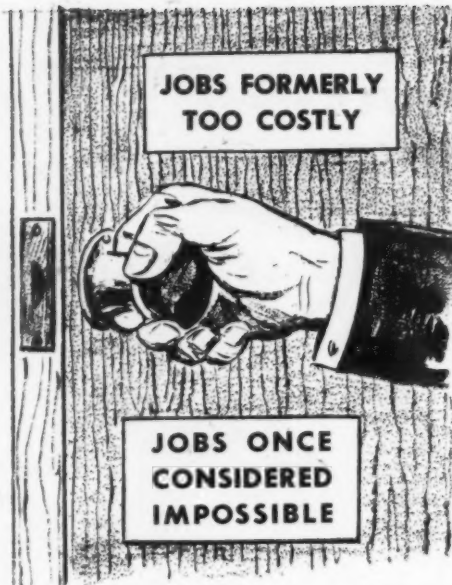
PLUGS AND RECEPTACLES • CIRCUIT CONTROLS • LIGHTING FIXTURES • FLOODLIGHTS

# "Buffalo" OPENS THE DOOR TO A BIG, NEW FIELD OF VENTILATION

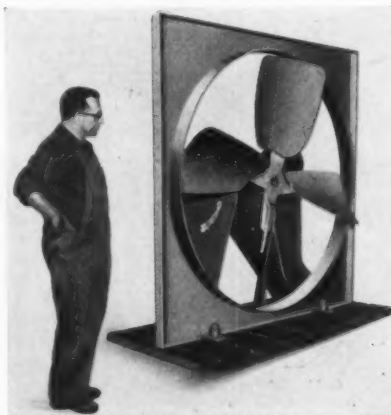
- "Buffalo" PACKAGE PROPELLER FANS in size range from 24" up to 144"!
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- Many special industrial and commercial applications formerly requiring major installations!
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- Performance-proved! All fans factory-run before shipment. All performance ratings in strict accordance with Test Codes of A.S.H.V.E., N.A.F.M., P.F.M.A. and U. S. Commercial Standard CS-178. "Buffalo" "Q" Factor\* construction in every one you order.

YOU'RE IN ON THE GROUND FLOOR of a rapidly expanding field, when you install "Buffalo" package propeller fans like these Belt-Airs. New orders coming in all the time for new and bigger applications. But don't delay! Have us mail you Bulletin FM-1234, or ask the "Buffalo" Engineer in your nearest major city.

\*The "Q" Factor—the built-in Quality which provides trouble-free satisfaction and long life.



Drive side of Design 53  
Belt-Air Fan (48" size)



Discharge side of 72" Design 53 Belt-Air. A complete package unit V-belted to 5 H.P., 1750 rpm motor, rated at 64,000 cfm at free delivery. We recently shipped 60 similar units handling 1,439,000 CFM for ventilating a large Coliseum in the Southwest.



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Industrial Exhausters Bolted Vent Sets Propeller Fans "E" Blowers-Exhausters

## 11.0 Residential

systems). Circuits or cables serving grounding type receptacles shall contain a grounding conductor firmly connected at the outlet to the box (if metal) or to the grounding terminal of the device.

### 11.31 Outlet boxes.

Outlet boxes shall be steel (non-metallic) of an approved type. Each outlet box shall be of the proper size and type for the fixture or device accommodated. Outlet boxes shall be fastened firmly in place with hangers, brackets, or other methods particularly designed and approved for the purpose.

Outlet boxes shall be (a) knockout type with separate cable clamps or connectors (locknuts and bushing, etc.), (b) equipped with integral cable clamps or connectors. Unused knockouts shall be left in place or provided with an approved closure.

Locknuts or connectors shall be set up tight to provide a firm mechanical and electrical connection.

Unless otherwise indicated, the following outlet boxes shall be used:

Ceiling Fixtures—4-in. octagonal 1½ in. deep.

Bracket Fixtures—4-in. octagonal 1½ in. deep with 2¾-in. round ¾ in. deep plaster cover.

Wiring Devices—Rectangular switch box, 3-in. deep ganged as required.

Where ceiling, bracket or device outlets serve as junction boxes or contain more than 6 (exclusive of fixture wires) conductors, they shall be 4-in. square 1½-in. deep with ¾-in. plaster cover appropriate for the fixture or devices.

Outlet boxes for flush devices on 30- or 50-amp circuits shall be 4-11/16 square 2½-in. deep with appropriate cover.

### 11.32 Branch circuits.

Furnish and install branch circuits from the panelboard(s) to the outlets shown on the plans or described in the outlet schedule.

### 11.33 Lighting.

Lighting and plug receptacle circuits in areas other than the kitchen, laundry utility room, basement or porch shall be 2-wire No. 14 (No. 12) 15-amp circuits. One circuit shall be provided for each 500 sq ft or fraction thereof of floor area.

More Specifications on Page 228



*This Permanent  
Underground Cable Provides  
Low Cost Wiring.*

# PARANITE PARAUSE<sup>®</sup>

( TYPE RR )

● Paranite Parause cable buries direct in earth to provide permanent installation from power line to meter, and for connecting buildings. CAA approved under specification L824. Can also be used in conduit or ducts. Conductors protected with heat and moisture-resistant rubber insulation. Outer Neoprene jacket gives added protection against moisture, elements in the soil, and acts as a cushion against injury to the current carrying conductors. Single, two and three conductors. *Write for Catalog!*

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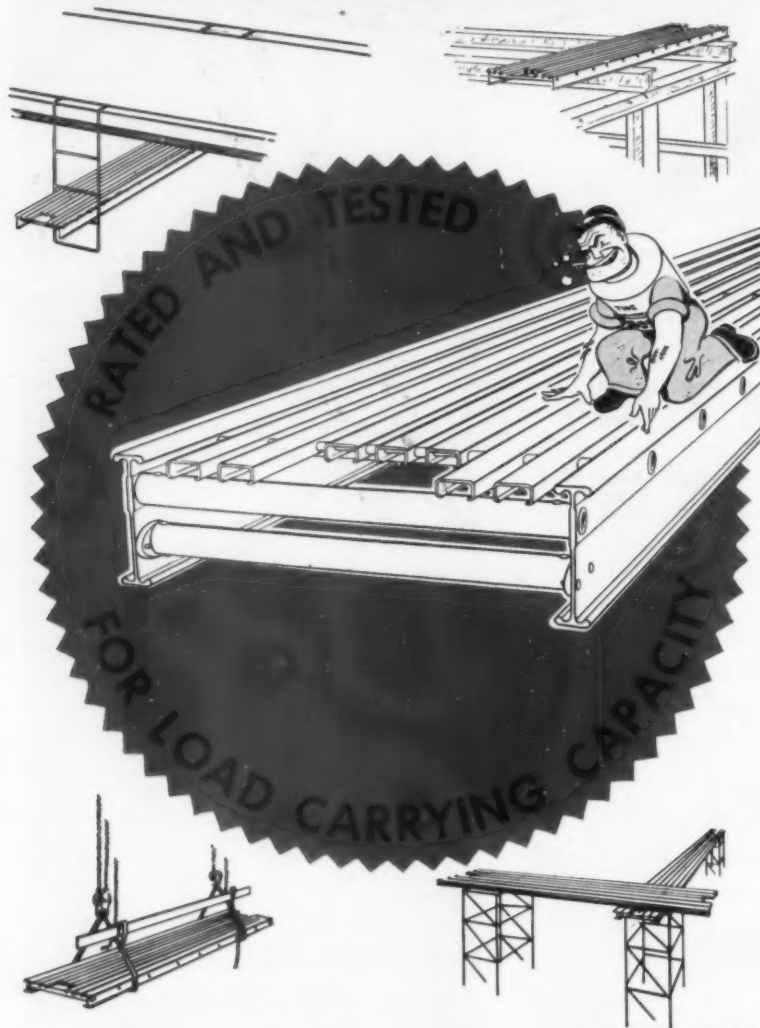


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## 11.0 Residential

### 11.34 Appliance.

Plug receptacles in the kitchen, laundry utility room, basement and porch other than those on special circuits shall be served by not less than two No. 12 20-amp appliance circuits. A 3-wire circuit may be used with individual receptacles connected alternately to either side.

### 11.35 Isolating.

Plug receptacles for the refrigerator and freezer and the outlet for connecting the heating plant shall be served by a separate No. 12 20-amp appliance circuit. (In some communities Codes may require an individual circuit to the heating plant.)

### 11.36 Individual.

Plug receptacles for connection of the following appliances shall be served by individual No. 12 20-amp appliance circuits:

Automatic clothes washer

Electric dishwasher and disposal unit

Bathroom heater

Nursery heater

Room cooler

Attic fan

Hobby bench

The outlet for connecting the electric clothes dryer shall be served by an individual 3-wire No. 10 circuit terminating in an approved 30-amp 3-wire flush (surface) receptacle.

The outlet for connecting the electric range shall be served by a 3-wire No. 6 circuit terminating in an approved flush (surface) 50-amp 3-wire receptacle.

The outlet for connecting the electric water heater shall be wired in accordance with the requirements of the local utility. (Local requirements vary depending upon metering provisions, permissible element capacities, etc. The utility rules should be consulted.)

### 11.37 Unit air conditioners.

A special purpose outlet, located at the most likely point of installation, on a separate No. 12 circuit should be installed in each principal living area and in each bedroom for unit air conditioners.

The use of general purpose or appliance circuits to serve air conditioners is *not* recommended. Even smaller units, though they may be rated within

More Specifications on Page 230



# New

## A REVOLUTIONARY NEW HOT DIP GALVANIZING FOR TRIANGLE ARMORED CABLE AND FLEXIBLE CONDUIT



Triangle's Armored Cable and Flexible Steel Conduit are now protected, inside and out, with a special process hot dip galvanizing (exclusive with TRIANGLE) that blankets the steel and every crevice completely with an even "Silver" coat. It not only gives perfect protection against corrosion, but it is clean, bright, smooth and allows full flexibility of the Armored Cable and the Flexible Conduit.

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- 1 Both are made from the finest steel and give rugged protection to the wires.
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3

In both, the interior surfaces are completely free of burrs and sharp edges.

4

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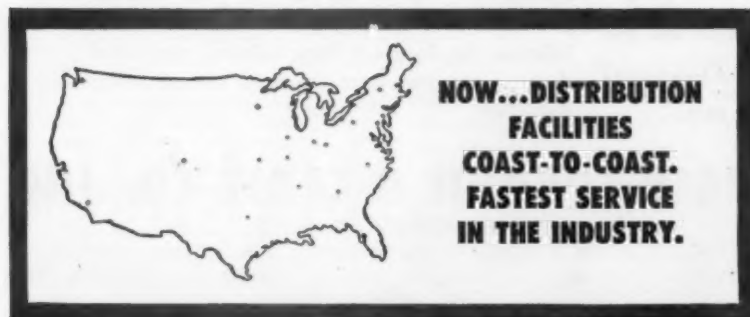
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This fast service plus consistent high uniform quality makes it pay you to always specify "General Cable" for all your electrical wire and cable needs.

## GENERAL CABLE CORPORATION



### 11.0 Residential

the capacity of such circuits, require a large portion of the circuit capacity under continuous duty over long periods of time. During this time the entire circuit and its other outlets are effectively disabled and inaccessible for other uses for which the circuit is intended, designed and installed.

Typical branch circuit schedule for a 1500 sq ft residence with conventional electrical appliances.

#### Full Circuits

Electric sink	1 — 20-amp
Automatic washer	1 — 20-amp
Ironer	1 — 20-amp
Air conditioner (room type)	2 — 20-amp
Hobby bench	1 — 20-amp

#### Heavy Duty Circuits

Range	2 — 50-amp
Water heater	2 — 20-amp
Dryer	2 — 30-amp

#### Isolating Circuit

Ref.; Freezer; Oil Burner	1 — 20-amp
---------------------------	------------

#### Appliance Circuits

Small appliances	2 — 20-amp
------------------	------------

#### Lighting Circuits

1500 sq ft	3 — 15-amp
------------	------------

### 11.4 Wiring Devices

Furnish and install where shown on plans or noted in the outlet schedule the wiring devices indicated. Flush devices shall be of the best quality (specify color). Plates shall be (composition, brass, etc.) and finished — (specify color or finish). Where more than one device is indicated at one location the devices shall be provided with one plate of the necessary size.

#### 11.41 Switches.

a. Furnish and install at each switch outlet a quiet operating, specification grade, switch, single-pole 3-way or 4-way as indicated.

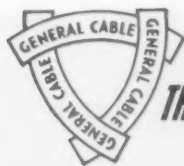
b. Furnish and install at each switch outlet a tumbler type switch T rated, single-pole, 3-way or 4-way as indicated.

c. Furnish and install at each switch outlet a rotary type, quiet operating switch.

Switches shall be provided with terminal screws. Connectors or screwless terminals to firmly terminate up to No. 10 conductors.

Furnish and install where shown on plans approved dimmer controls of the capacities noted. Controls shall be of the variable reactance type and

*More Specifications on Page 232*



**THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE**



## BUILDING WIRES

General Cable GUARDIAN Building wires represent the highest type of product available under any of the Code classifications. Every step during manufacture is quality controlled, with all the responsibility of General Cable behind it.

GUARDIAN wires are available in many types: Braided Types R, RH-RW and RHW; Thermoplastic Type TW; Lead Covered Types RL and RHL; Neoprene Jacketed Types RH-RW and RHW.

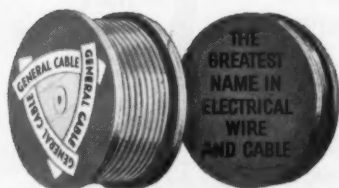
Braid covered wires are hard finished, slick and smooth—easy to pull without any need for lubricant . . . standard color coding, of course. Type

TW is similarly easy to handle and its minimum diameter will add circuits where conduit space is limited.

All types of GUARDIAN are easy to strip clean for joining, and in all ways help to keep the job moving. When you order your Building Wire, say "General Cable GUARDIAN" to your electrical supply house — and be sure of a good job, profitably handled.

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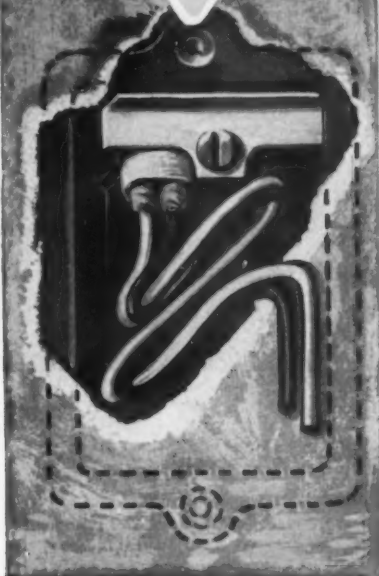
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SEAL\*



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\*UNION'S "Plaster Seal" is a thin molded section covering the device screw holes in UNION switch boxes — easily removed with point of screw or corner of screwdriver.

**UNION INSULATING CO.**  
Parkersburg, West Va.

## 11.0 Residential

shall be installed and connected in an approved manner and in accordance with manufacturers' instructions.

### 11.42 Receptacles.

Furnish and install at receptacle outlets on lighting circuits a (duplex, triplex) plug receptacle, 15-amp, 120-volt for parallel blade attachment caps.

Furnish and install at receptacle outlets on appliance circuits a grounding type duplex plug receptacle, 15-amp, 120-volt designed to handle either parallel blade or grounding type attachment caps.

At locations shown on plans furnish and install

a. (for 115-volt air conditioners) a 15-amp 125-volt grounding type receptacle of the parallel blade type.

b. (for 230-volt air conditioners) a 15-amp 250-volt grounding type receptacle of the tandem blade type.

Each outlet for air conditioners shall be served by a separate No. 12 2-wire circuit from the panelboard located as shown. Circuits shall be arranged to serve 115- or 230-volt equipments as shown on plans.

Receptacles and plates located outdoors shall be weatherproof type with screw cap closure.

The receptacle contacts shall be designed to grip both sides of each blade. Terminal screws or connectors shall be designed to firmly terminate up to No. 10 solid conductors.

### 11.43 Multi-outlet assemblies.

Multiple outlet assemblies shall be furnished and installed where shown on the plans or indicated in the outlet schedule. Each section shown shall be continuous with outlets spaced — in. apart.

On lighting circuits the assembly shall be designed to take standard parallel blade attachment caps.

a. They shall be two-wire type with switch control as shown or described on the outlet schedule.

b. They shall be the divided circuit type with the upper positions switched as shown.

On appliance circuits the assembly shall be grounding type designed to take either standard parallel blade attachment caps or grounding type attachment caps on any outlet.

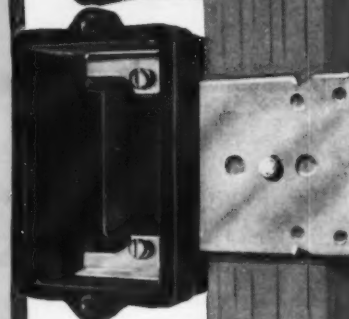
More Specifications on Page 234

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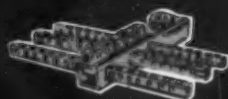


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## 11.0 Residential

### 11.5 Surface Wiring

Where wiring is run exposed in basement, garage and attic space, surface type wiring devices shall be used. Devices shall be mounted firmly as recommended by the manufacturer and wiring securely installed. Cable shall be independently fastened in place within six inches of terminal connections.

Surface devices, raceway installation. When wiring is run exposed as in basement, garage and attic space, outlets, boxes and devices shall be suitable for exposed work and shall present a neat and workmanlike appearance.

a. Boxes shall be pressed steel type with rounded corners and fitted covers designed for the devices installed. Raceways shall be installed square (rigid conduit, EMT).

b. Raceways shall be surface type steel raceways installed square with elbows, boxes, connectors and closures designed specifically for use with the raceway and of the same manufacture.

### 11.6 Kitchen Fan

Furnish and install when shown on plans as kitchen exhaust fan Catalog No. — as made by — or approved equal. Fan shall be designed to handle not less than — cu. ft. of air per minute. External opening shall be provided with (specify type of louver, closure, or vent). Fan shall be controlled by (specify type and location of switch).

### 11.7 Relay Switching

Switch control of the outlets noted on the plans shall be provided by a low voltage remote control system as made by — or approved equal. (See Relay Switching in 6.0 Branch Circuits for detailed specifications.)

### 11.8 Space Heating

Specifications for electric space heating should describe the type, capacity and location of each unit or group of units and the type and location of each thermostat and associated relay designating the units controlled. Heating equipment should be installed in accordance with Article 428, noting particularly 4271 through 4286, of the National Electrical Code.

More Specifications on Page 236

## New RLM Specifications for:

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3. MAXIMUM BRIGHTNESS
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3	Yes	Yes	
4	13°-14°	27°	13°-14°
5	85%	85%	85%
6	83%	77%	80%
7	Yes	Yes	Yes
8	Yes	Yes	Yes
9	Yes	Yes	Yes
10	5"		5"
11	Yes	Yes	Yes
12	Yes	Yes	Yes

### 22 INCANDESCENT UNITS

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Both fluorescent and incandescent RLM Specifications for 1955 include important improvements. In step with illuminating engineering progress, RLM Standards take recognition of industry's ever-increasing demand for more light, both on working surfaces and ceilings; better shielding; increased efficiency; easier and lower-cost maintenance.

In addition to the 12 advancements listed here, there are many other important revisions in the new RLM Specifications. These changes bring advantages that make specifying units bearing the RLM Label more important than ever!

A complete compilation of all new RLM Specifications covering 46 different types and sizes of incandescent and fluorescent industrial lighting units, may be found in the new 1955 RLM Specifications Book.

Included are the names and addresses of RLM participating manufacturers who make one or more lighting units bearing the RLM Label. For your complimentary copy, sent without obligation, please address your request on your company letterhead to:

RLM Standards Institute, Suite 819  
 326 W. Madison St., Chicago 6, Ill.



11845

# The professional approach to selecting a REMOTE CONTROL SWITCH

As a professional in the electrical field you are already aware that a modern electrical system requires control of electrical circuits from several conveniently located stations.

With the need established for remote control switches, you must then determine the number of circuits to be controlled and the electrical requirements of the system—considering the class of load to be handled.

## When making these studies, it's wise to remember that:

ASCO Remote Control Switches are available with up to 24 poles, single or double throw.

Unlike most remote control switches, ASCO remotes may be used to full rated capacity for tungsten, fluorescent, mercury vapor and all noninductive loads. ASCO switches are also rated for motor or mixed loads.

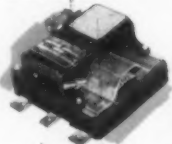
Knowing these important facts about ASCO Remote Control Switches will help you select the control that best suits your requirements.

## Bear in mind, too, that ASCO Remote Control Switches permit:

- distribution panels to be so located that straight feeders and short branch circuits result in minimum line drop and losses.
- control stations at convenient points for instant disconnect of lighting and power feeders under normal and emergency conditions.
- logical distribution to determine design and make wiring layout simple and flexible for future expansion.

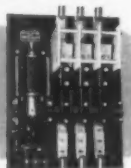
There's *one source* for a complete line of remote control switches—ASCO. Write for complete data—and for the easy-to-use sheet that details this method of selecting a remote control switch, as well as how to apply noninductively rated switches to motor loads.

For economy and rugged construction ...



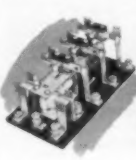
Use the Bulletin 920—Up to 3 Poles, Single Throw, 30-75 Amps D-C, 30-200 Amps A-C, U. L. Approved to 600V A-C, 250V D-C. Recommended for all loads within its capacity range.

For Load Requirements Exceeding Capacity of the Bulletin 920 ...



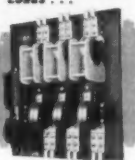
Use the Bulletin 910—Up to 4 Poles, Single Throw, 30-400 Amps, 250 volts, A-C or D-C.

For Small Panel-boards ...



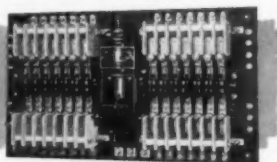
Use the Bulletin 909—Up to 3 Poles, Single or Double Throw, 30 Amps, 250 volts, A-C or D-C.

For High Capacity, Highly Inductive Loads ...



Use the Bulletin 911—Up to 4 Poles, Single Throw, 30-100 Amps, 600 volts A-C, 250 volts D-C.

For Multiple Pole Requirements ...



Use the Bulletin 915—Up to 24 Poles, Single or Double Throw, 30, 60, and 100 Amps, A-C or D-C.

# ASCO

Automatic Transfer Switches  
Electromagnetic Controls  
Solenoid Valves

Automatic Switch Co.

385-Q Lakeside Avenue • Orange, N. J.

## Electrical Specifications

### How to Prepare Wiring Plans

The steps to follow in preparing the wiring plans are:

Initial space provisions: Obtain tentative location and type of service, especially if current is to be supplied by the power company, based on the approximate demand for the building. Assign liberal spaces and clearances to accommodate service raceways, service equipment, transformer stations, and main distribution center. Final details can be determined only after the layout is completed and the load has been computed.

Lighting layouts: Locate and mark by standard symbol all (1) lighting outlets, (2) convenience, appliance, heavy-duty or other special outlets, local or multi-location switch controls (show outlets they control), (3) special lighting equipment built into architectural features of the space, (4) outlets or built-in lighting equipment in fixtures, furnishings or machines. Determine circuit distribution, interconnect outlets, and assign circuit numbers. Where the wire is larger than the minimum specified, show the size, the number of wires per run, and the size of raceway to be used. Under-floor or cellular floor systems are preferably shown on separate plans. Manufacturers can provide typical floor plans. Extensive fluorescent lighting systems of close-spaced troffers, luminous ceilings and similar installations should also be shown on separate plans which also show other mechanical and electrical features which must be considered in the installation (sprinkler heads, air conditioning, outlets, etc).

















Power layouts: Locate and mark by standard symbol all (1) motors, (2) controllers, (3) stationary heating devices, (4) remote control and auxiliary control devices, (5) power panel-boards. Determine branch circuit distribution, wire and raceway size, and assign circuit numbers.

Where any considerable number of motors is to be connected, the location of each motor and other power equipment, such as heaters, should be shown on the plans, also showing the hp or kw rating, the kind of machine driven and the location of the con-

More Specifications on Page 238



# WIRE CONNECTORS • Condensed Data

TYPE	TRADE NAME	USE	INSULATING PROPERTIES	MECHANICAL PROPERTIES	WIRE COMBINATIONS	APPROVALS
<b>SCREW-ON</b> 	 <b>Wire-Nuts</b> <b>CONNECTORS</b>	Pigtail splices. Pressure cable connectors for general use in all branch circuit and fixture wiring.	Shell of phenolic compound. High dielectric and mechanical strength. Withstands 4000 V. potential test.	Helical cone spring integral with shell. Compresses wires, twists and cross threads them in one operation.	2 No. 18 to 3 No. 10 and 1 No. 18	 and  Contractor sizes 74 and 76 approved as pressure cable connectors for general use. These and all other sizes approved for fixture use.
<b>SET-SCREW</b> 	 <b>SET-SCREW</b> <b>CONNECTORS</b>	Pigtail splices. Pressure cable connectors for general use in all branch circuit and fixture wiring.	Shell of phenolic compound. High dielectric and mechanical strength. Withstands 8000 V. potential test.	Solid brass sleeve and set-screw. Permits visual inspection of completed joints.	1 No. 14 and 4 No. 18 Str. to 6 No. 14	 Contractor sizes 11 and 22 for general use, (600 V.). No. 10 for 300 V. fixture connections.
<b>CRIMP CONNECTOR</b> 	 <b>CRIMP CONNECTOR WITH</b> <b>"Wrap-Cap"</b>	Pigtail splices. Pressure cable connectors for general use in all branch circuit and fixture wiring.	Wrap Cap, vinyl material. Insulates all around and between wires. Double thickness over sleeve and wire ends. Withstands 8000 V. potential test.	Sleeve of cadmium plated steel, open at both ends for visual inspection. Double indentation by IDEAL Crimping Pliers gives maximum holding power.	1 No. 18 and 1 No. 14 to 2 No. 10 and 2 No. 14.	 and  For general use (600 V.) in all branch circuit and fixture wiring.
<b>TAP CONNECTORS</b> 	 <b>TAP CONNECTORS</b>	Pigtail splices, parallel splices and T-taps on larger size wires. Types for copper-to-copper, copper-to-aluminum and aluminum-to-aluminum.	None. Use in general insulating materials such as tape or insulating compounds when needed.	Large contact area and extreme pressure provided by hex head screw. Unitized design with no loose pieces.  Cold worked steel with zinc plate and chromate dip.	2 No. 1 to 1 No. 8 and 1 No. 14	
<b>SERVICE ENTRANCE CONNECTORS</b> 	 <b>SERVICE ENTRANCE CONNECTORS</b>	Pigtail and parallel connections. Types for copper-to-copper, aluminum-to-copper and aluminum to aluminum.	None. Use in general insulating materials such as tape or insulating compounds when needed.	Heavy body will not distort. Slotted hexagonal head set-screw.  Bronze or tin-plated bronze with spacer bar.	2 No. 10 Str. to 2 No. 2 Str.	

**Check the "Specs" — but Look for More when you Pick the Product!**

- Who Makes It?
- Is It Job Proven?
- How Does It Stack Up with Contractors and Users?

**YOU'LL BE SAFE AND SURE WITH  WIRE CONNECTORS**

Whatever type of wire connector you prefer, one of those made by IDEAL will meet your choice, performance requirements and specifications. IDEAL has been making and pioneering in the design of wire connectors for over 30 years—and in all of this time has set standards supported by the industry. When you specify an IDEAL Connector, you are sure your customer is safe. Above are data on the various IDEAL Connectors. But even more important to you, are the quality control and exacting manufacturing back of these IDEAL Connectors.

These are your assurance of performance, dependability and job satisfaction when you specify IDEAL Wire Connectors.

IDEAL WIRE CONNECTORS ARE SOLD, STOCKED AND RECOMMENDED BY LEADING DISTRIBUTORS. SEE YOUR IDEAL DISTRIBUTOR FOR FURTHER INFORMATION, OR WRITE FOR CATALOG DATA.

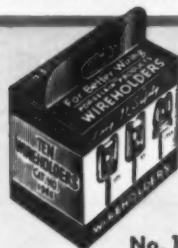
 **IDEAL INDUSTRIES, Inc.**  
1041 Park Avenue, Sycamore, Illinois

# Out in FRONT

**NOW PACKAGED  
IN A HANDY  
CARRYING CARTON**



No. 1986



**PACKED IN THIS  
MERCHANDISING CARTON**



No. 1929 No. 1984 No. 1986

**ALSO**



No. 1933

## PORCELAIN PRODUCTS

### Wireholder Merchandising Pack



Porcelain Products' wireholders *sell* because they're pace-setters. They're dependable—rugged . . . and packaged in a carton that is convenient to handle. It's practical—handy.

Porcelain Products' wireholders and secondary service materials have been known as *Quality Products* for years because of their strong, sturdy construction. Metal reinforced wireholders are designed with metal in tension, porcelain in compression—hot-dip galvanized steel parts. All wireholders have sharp, fast driving screw threads—large pulley-action wire holes—and many more features.

Porcelain Products' wireholders give you more value for your dollar—greater customer satisfaction. See your distributor.



**60  
years**

ELECTRICAL PORCELAIN SINCE 1894

**Porcelain Products, Inc.**

FINDLAY, OHIO

**PP  
INC.**

## Electrical Specifications

troller. It is well to assign a number to each motor and to prepare specification sheets giving for each motor or heater its number, location, hp or kw rating, description of machine driven type of controller to be used and auxiliary control equipment.

**Auxiliary system layouts:** Locate and mark by standard symbol all (1) auxiliary system outlets, such as speakers, telephones, gongs, annunciators, etc., (2) junction or terminal cabinets, (3) batteries, transformers, or other power supply sources. Determine circuit routing, indicate on plans and riser diagram, and provide for panelboard circuits to supply auxiliary systems.

## Circuits

**Circuit runs:** For concealed work in fireproof construction, circuit runs should as far as possible be shown as straight lines from outlet to outlet. For concealed raceway work in wood joist construction, right angle bends must as a rule be used and it is preferable to lay out the work in such manner as to indicate such bends on the wiring plan. For exposed work the approximate actual position of the runs should be shown.

**Abusive or hazardous area design:** Isolate or place in a separate room wherever possible all equipment the safe or successful operation of which would be affected by (1) abrasive metals, dust and chips, (2) condensation, (3) corrosive atmospheres, (4) excessive temperatures, (5) grease and oil, (6) excessive vibration, (7) water drizzle or splashing, (8) explosive dusts or fumes, (9) ignitable fibres, flying or accumulations, (10) flood water. Provide sealing fittings in raceways leading to rooms of widely different temperatures, to prevent air circulation within such raceways.

**Final calculations:** Calculate, route and indicate on plans and riser diagram the complete feeder system, main distribution equipment, and service equipment.

**Lighting outlets:** In many cases, particularly in industrial plants, either the various classes of work to be done have not been assigned to definite spaces in the building when the wiring layout is made, or there is a proba-

*More Specifications on Page 240*



# MANUAL STARTERS

CATALOG  
NO. 6808



## FOR QUICK, EASY WIRING and SERVICING

For starting and stopping, without overload protection, motors rated up to 2 hp, 600 volts. Supplied in general purpose, flush and weatherproof types. Other Manual Starters are available for push button or toggle operation, with or without overload protection, for 1, 2, 3 or 4 pole use.

Mail coupon for free 12-page catalog section describing the complete line of A-H Manual Starters.

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INDUSTRIAL CONTROL DIVISION

103 HAWTHORN ST., HARTFORD 6, CONN.

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CINCINNATI      LOS ANGELES      PITTSBURGH      TORONTO, CANADA  
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**Quality**

MOTOR CONTROLS      WIRING DEVICES  
ENCLOSED SWITCHES      APPLIANCE SWITCHES



INDUSTRIAL CONTROL DIVISION

ECM

THE ARROW-HART & HEGEMAN ELECTRIC CO.  
103 HAWTHORN STREET, HARTFORD 6, CONN.

Please send my copy of the illustrated Catalog Section "A-H Manual Starters."



NAME \_\_\_\_\_  
POSITION \_\_\_\_\_  
COMPANY \_\_\_\_\_  
CO. ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

## An ELEFILAMENT never forgets. Do You?



Starting small, the Elefilament glows and grows until he becomes a bulky barrier to effective and economical lighting, unless you set a trap for him by maintaining good lamps and good lamp care at all times.

By good lamps we mean CHAMPION Lamps, made specially to meet the highest standards of industrial lighting.



*By good lamp care we mean the simple, effective maintenance measures described in the Champion Maintenance Manual, copy of which is yours for the asking.*



**CHAMPION LAMP WORKS**  
312 Lynnway, Lynn, Massachusetts

## Electrical Specifications

bility that at some future time machines and other equipment will be relocated. In all such cases, wiring capacity should be provided that will be sufficient for the maximum probable need.

### Layout

The first step in laying out a wiring system is to determine the outlet locations and loads.

As the architectural features of the room or space become more important, the choice in the location of outlets becomes more and more restricted. Extreme cases are churches, theatres and similar buildings of somewhat elaborate architectural treatment, where the lighting equipment, whether concealed or exposed, must be located so as to fit properly in its surroundings. Similar conditions may be met in some retail stores, hotel and office building lobbies, lodge halls, libraries, banking rooms, etc. At least a preliminary design of the lighting system should be made in these cases before the wiring is laid out.

Any space that is to be occupied as an office in an industrial building is to be treated as an office, while a workshop in a commercial building is to be treated as industrial.

**Incandescent lighting loads:** To determine the wattage loads after the outlets have been located, take the watts per square foot required, for the given case multiply this figure by the total area of the space, in square feet, to find total watts. This result divided by the total number of outlets gives the computed watts per outlet.

**Example:** A retail store sales room measures 45 ft by 96 ft and there are 18 ceiling outlets. Single-lamp fixtures are to be installed. What is the proper wattage per outlet? The standard load is 4 watts per sq ft.

45 by 96 = 4320 sq ft total area  
4,320 by 4 watts = 17,280 watts

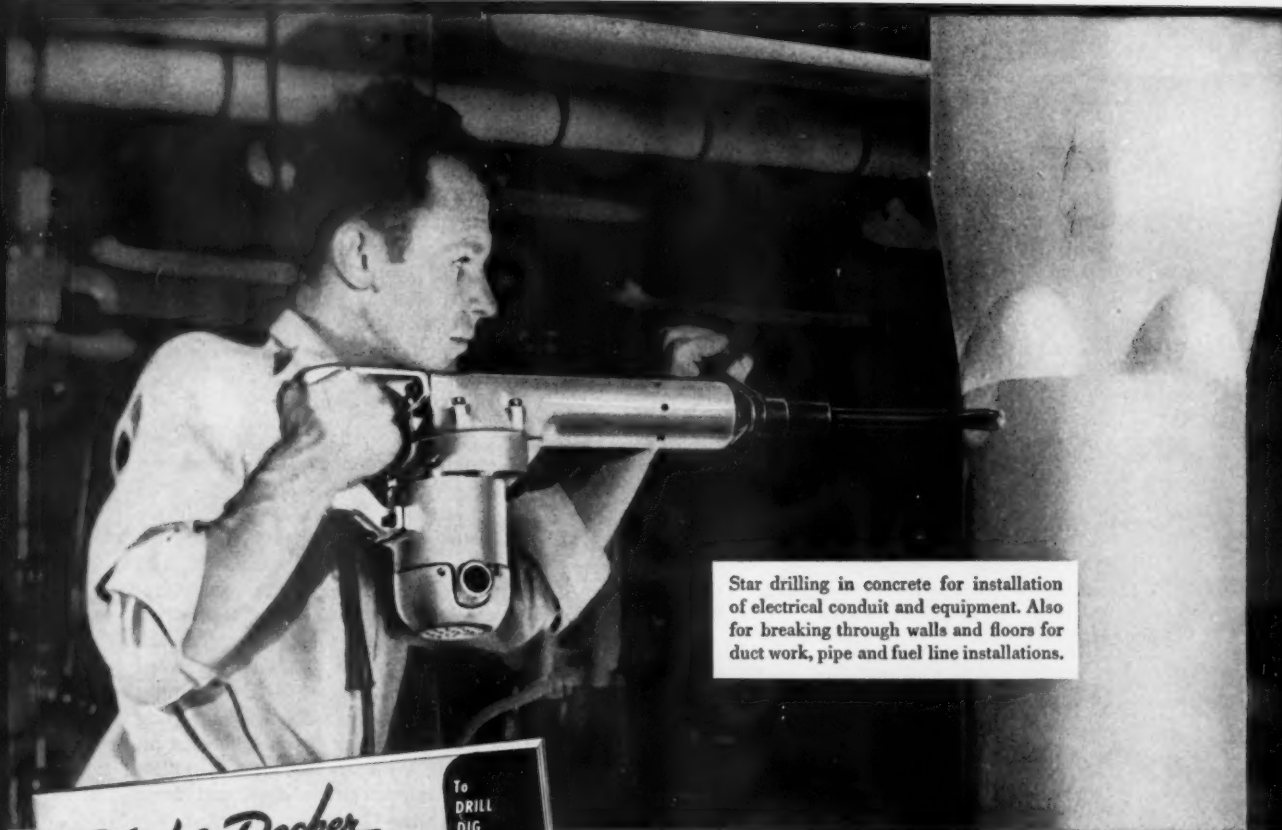
$\frac{17,280}{18} = 960$  watts per outlet

This wattage should then be adjusted to 1000, this being the nearest commercial lamp rating.

In those cases where an illumina-

**More Specifications on Page 242**





Star drilling in concrete for installation of electrical conduit and equipment. Also for breaking through walls and floors for duct work, pipe and fuel line installations.



## See where B&D Hammers save you time and money!

# New Book shows how!

From drilling in concrete to holing-through walls, B&D Electric Hammers get more jobs done faster, better, cheaper! No other Hammer has so many features for comfort and safety. No other Hammer gives you so much working power in so little weight at such a low price! Get all the facts! Get this great B&D Hammer Handbook **FREE!** Page after page of on-the-job photos show how you can save time, cut costs on dozens of jobs in your own operation! Write to: THE BLACK & DECKER MFG. Co., Dept. 2305, Towson 4, Maryland. Meanwhile, ask your B&D distributor for a demonstration!

LEADING DISTRIBUTORS EVERYWHERE SELL

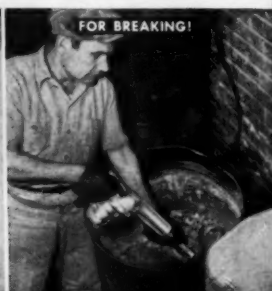
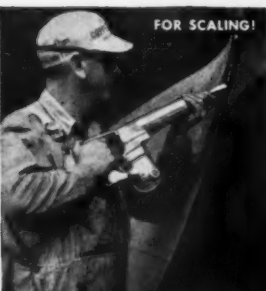
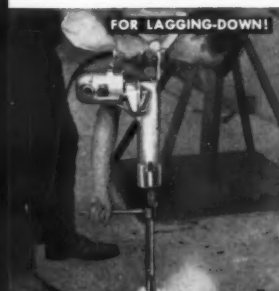


For nearest distributor, see "Tools-Electric."

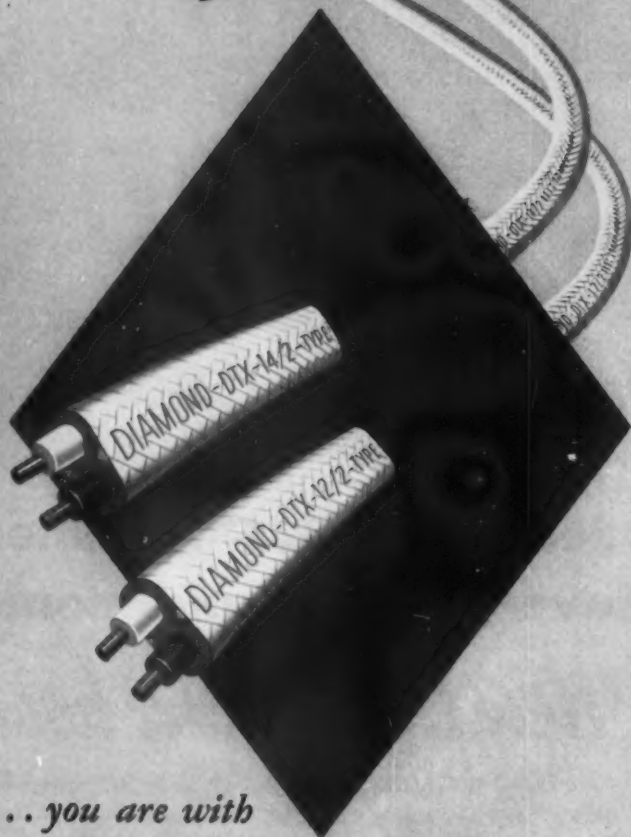


# Black & Decker

**PORTABLE ELECTRIC TOOLS**



**IN THE BLACK-  
WITH WHITE?**



*... you are with*

## **DIAMOND DTX**

### **NON-METALLIC SHEATHED CABLE**

● Diamond DTX is *really* white! Non-sticking, smooth and easy to pull.

- Walls stay clean!
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- Does not flake off!

For a fast, clean installation... get  
**DIAMOND DTX!**

*Write today for Catalog and Samples.*



**DIAMOND WIRE & CABLE CO.**

SYCAMORE, ILLINOIS

## **Electrical Specifications**

tion system has been designed and specified to produce values of illumination intensity lower than the maximum values referred to above, the wiring layout nevertheless should be based upon the standard lighting load tables.

## **Fluorescent Lighting**

**Fluorescent lighting loads:** To determine loads required for fluorescent lighting an illumination design must be prepared for typical areas and the watts per square foot determined for each type of lighting application. For instance a school project would require a class room layout, auditorium layout, corridor layouts, etc. In each case the watts per square foot required would then be applied to all similar areas in the building. The wiring capacity required to serve fluorescent lighting loads, the location of outlets and control can be developed from the lighting layout.

Historically, desired illumination intensities have doubled every ten years. Cost considerations often tend to hold original lighting installations in a new building to the lower acceptable levels of the time of construction. After 10 to 15 years the original installation will probably be "modernized" to bring it up to the then acceptable standards of illumination.

Consideration should be given, therefore, to the probability of substantial load increase on the wiring system with lighting progress.

**Lighting branch circuits:** Having determined the outlet location and the watts per outlet, or outlets per circuit, the number of branch circuits should next be determined. It is preferable to make a final check by laying out the circuits on the floor plans. The number of circuits for general illumination is determined from the outlet wattage, and the usual limit is 1000 watts per circuit for 15 ampere circuits. For loads operating continuously over long periods of time, (school lighting, industrial general lighting etc.) the current should not exceed 70% of the circuit capacity and must not exceed 80%.

For example, for continuous operation the incandescent lamp load on a 20-amp circuit should not exceed 1680 watts (at 120 volts) or 14 amps.

*More Specifications on Page 245*

SPECIFY

**P.W.**

FOR

**CABLETROF TUBETROF Twist-Rack****AND CABLE INSTALLATION EQUIPMENT**

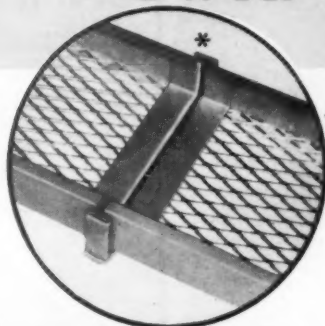
P-W salutes the Philadelphia Electric Co., as the originators, designers and first users of a cable trough system made of expanded metal. As a result of this pioneering by P. E. Engineers, other Utilities, Industrials and Governmental Agencies have benefitted in

lower cable installation costs.

P-W again offers additional savings with (1) its new **EXTENSION FITTING**, which eliminates cutting of trough to complete runs, and (2) with its built-in

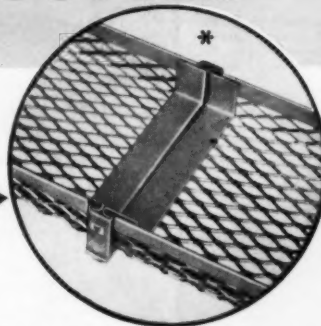
**"QWIK-LOK" COUPLER**

Savings  
up to  
**90%**  
in  
Assembly  
Time



For trough with channel sides.

For trough with expanded metal sides.



Just Takes  
One Man  
and  
a few taps  
of a  
Hammer

**ALL WIDTHS AND HEIGHTS . . . ELIMINATES NUTS, BOLTS & WASHERS**

This coupler provides: a stronger, quick-coupling — full support in bottom of trough — entirely hot-dipped galvanized — permits trough or fitting to be easily

removed or inserted from side of run after original installation — bolt-on coupler also available — can also be used as Drop-Out fitting.

**ASK OUR REPRESENTATIVE TO SHOW YOU THE "QWIK-LOK" COUPLER***Representatives*

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\*Patent Pending



**WRITE FOR BULLETINS**  
**INDUSTRIES, INC. Manufacturers**

DUNCAN AND MELROSE STREETS

PHILADELPHIA 24, PA.

# MULTI

## FOR SCHOOLS



Cat. No. 3088 with  
Hinged Wire Guard

Gymnasium fixture for flush mounting in suspended ceiling. Serviceable from above or below. Reflector is lifetime porcelain enamel on steel.

Lamp size 300-500 Watts



Cat. No. 4090

High bay RLM reflector for open ceiling gym. Made in alzak finish aluminum or porcelain enameled steel.

Lamp sizes 300-500 Watts  
750-1500 Watts



Cat. No. 3276

Swimming pool fixture lifetime porcelain enameled reflector. Cast aluminum pendant fitter. Globe can be clear, opal or heat resisting.

Lamp size 300-500 Watts



Cat. No. 3071

Shower room fixture. Porcelain enameled canopy. Aluminum guard.

Lamp size 150 Watts

# LIGHTING EQUIPMENT DESIGNED FOR LASTING SATISFACTION

## FOR INDUSTRY

THE NAME  
KNOWN FOR  
QUALITY



BACKED BY  
OVER 35 YEARS  
EXPERIENCE



### New RLM Specification FLUORESCENT FIXTURE

Basic 2 lite 40 Watt with upward light component. ETL turret sockets, ballast & accessories. Also available for 3-40 Watt Lamps; continuous tandem installation or with 4' and 8' blank channel. Also available with rapid start ballasts.



RLM DOME  
With Multi Thredlok Socket

Lifetime porcelain enameled steel reflector. Made Dome, shallow bowl, flat cone, deep bowl & angle. Thredlok socket allows for fast, labor saving maintenance. Reflector, lamp & socket removable as a unit means less out of service delays.

Lamp sizes range from 100 Watts to 1500 Watts



Ceiling fixture for general lighting of uniform distribution with some indirect lighting without glare. Pan is 18 GA. Aluminum anodized etched finish. Opal globe is 8, 10, 12, 14, 16 inch Dia. for one 60 watt lamp up to three 100 watt lamps.



Multi ile-lite scientifically designed for efficiency lighting of library shelves & stockroom aisles. Available with pendant, box cover, angle, or feed thru socket fitting, also with pull chain socket.

Lamp sizes—100-150-200 W.

### SPECIAL BULLETINS YOURS UPON REQUEST

No. 954—6-page Condensed Catalog

No. 754—Multi Ceiling Fixture

No. 555—New Complete on Sparlites

For Air Mail Reply

Address request to Dept. RK

## FOR FLOODLIGHTING



Cat. No. 539B-1000 W.

Alzak finish aluminum reflector, cast aluminum socket housing. Specially designed for athletic fields, billboards, playgrounds, racing tracks etc. Heat & impact resistant lens, sturdy positioning handle & many other quality features.

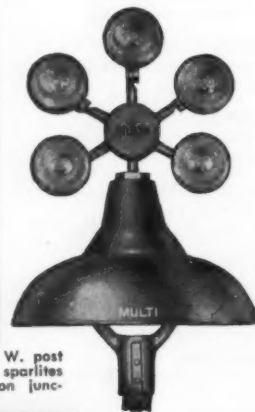
Lamp sizes 300-500 W.  
750-1500 W.

Medium or narrow spread



Cat. No. 610  
For  
PAR 38 - 150 Watt  
R40 - 150 Watt  
Lamps

Cast aluminum sparlites all weather tight with silicone rubber gasket. Ready wired. For accent spot & floodlight. Complete with mounting accessories & fittings. Also for Mogul R40 & PAR 56 lamps.



Cat. No. 3875  
Complete unit  
as shown.

Multi 500 W. post light with sparlites mounted on junction box.

# MULTI

ELECTRIC MFG. INC.  
4223 W. LAKE ST.  
CHICAGO 24



## Electrical Specifications

For fluorescent lighting the rated lamp wattage does not provide an exact measure of the current, which includes ballast losses. For high power factor ballasts a widely used design factor is 1.25 times the lamp wattage (thus 2-40-watt fluorescent lamps would equal 100 watts for circuit and load purposes).

Convenience outlets: The use for which convenience outlets are intended or likely to be used should be carefully considered. A maximum of six outlets on any receptacle circuit is a conventional limit but this number should be reduced unless the actual loads are readily predictable.

Trends in office appliances not only show much wider use of electrically operated equipment but substantially more power required for the individual devices.

In merchandising areas, convenience outlets located to serve portable or temporary displays usually require a full circuit.

Retail stores will require special outlets for supplementary show window lighting, wall case lighting and other special displays.

Outlets for show window lighting should usually be located on the sides of the columns, at or near the height at which the lighting equipment is to be located.

Floor outlets for show case lighting should be located from final plans showing the exact locations of the store fixtures. In a small store having an unfinished basement, circuits may be carried down from the cabinet to a junction box in the basement. These circuits may be run to the desired locations after the fixture locations have been determined.

Outlets for wall case lighting can usually be located in the wall so as to be just above the cases. Wiring can then be extended on the tops of the cases to the lighting equipment. Where display cases back of the counters and on the column lines are to be lighted, outlets may be located on the column just above the cases, or if this is not feasible, floor outlets must be provided.

### Heavy Duty Circuits

Heavy-duty branch circuits: Where the entire load on a circuit consists

*More Specifications on Page 252*



# INVITATION TO NEW BUSINESS

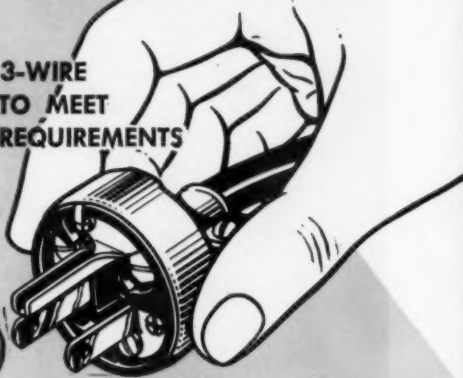
**A COMPLETE LINE OF 3-WIRE  
GROUNDING DEVICES TO MEET  
CODE REQUIREMENTS**



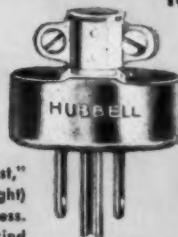
**No. 5262**  
Specification Grade  
Convenience Outlet



**No. 5273-L**  
Heavy-duty  
Composition Adapter



**Rugged 3-Wire Caps  
with U-shaped Blade  
for Grounding**



**No. 5264**  
Armored cap  
with cord grips.



**No. 5274**  
Finger-grip type



**No. 5266**  
Rubber cap  
with cord grips.

Whenever grounding is a "must," 3-wire grounding caps (see right) are your invitation to new business. As you know, caps of this kind with U-shaped grounding blade are required by N.E.C. and U.L. on many types of portable electrical equipment rated 125 volts or less.

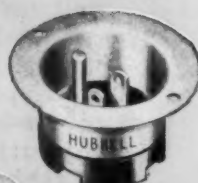
Point is this: Some of your industrial customers are going to be surprised when they receive portable tools and machine tools equipped with this new 3-wire cap. It will present a plug-in problem . . . unless they have the receptacles, adapters, connectors, etc., to accept the new U-shaped grounding blade.

Don't miss this chance to sell them the devices they'll need. Hubbell's complete grounding line meets every requirement, satisfies the top industrial standard for rugged, dependable performance.

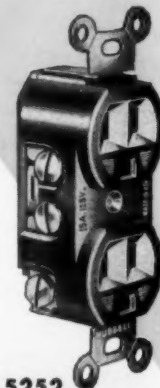
Also a complete line of 250-volt rated grounding devices. Literature on request.



**No. 5279**  
Motor Plug Base (female)



**No. 5278**  
Motor Plug Base (male)



**No. 5252**

Competitive grade  
convenience outlet  
for residential  
applications.



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## DOSSON "F" SPLIT BOLT CONNECTOR

Fabricated from high strength alloys (better than average steels), the Dosson "F" is cold-formed for uniform quality. Maximum contact pressure is assured by a high translation of tightening torque. Full length pressure bars with rounded edges prevent load concentration and crushing of conductor. Built to withstand high overload, vibration. Highly corrosion resistant.

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Dosson "F" Connector**



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249 Huron St., Brooklyn 22, N. Y.

Gentlemen:

Please rush free sample Dosson "F" Split Bolt Connector plus catalog sheet.

Name ..... Title .....  
Company .....  
Address ..... Zone ..... State .....  
City .....



**DOSSERT MFG. CORP.**

249 Huron St., Brooklyn 22, N. Y.

### Electrical Specifications

of mogul-base lamps or mercury-vapor lamps, special high capacity circuits may be used. These are known as "heavy-duty circuits." These circuits may consist of No. 12, No. 10, or No. 6 wire, with overcurrent protective devices rated or set at 20-amp, 30-amp, or 50-amp, respectively.

For mogul-base incandescent lamps, these high capacity circuits should be so laid out that the initial load may be increased by substituting lamps of the next larger size. Circuits of No. 12 wire need not be considered because with this size the voltage drop would be excessive unless the circuits are very short. For circuits of larger wire the initial loading should not exceed 1500 watts for No. 10, nor 3000 watts for No. 6.

Voltage drop: The voltage drop on lighting branch circuits should preferably not exceed 2%. It is not practical to calculate the wire size for every circuit, because too much time would be required to make the calculations, and in order to avoid unnecessary complication it is better to use not more than two sizes of wire.

Some layouts provide for a larger size conductor in the "home run" from the panelboard to the first outlet on the circuit to reduce voltage drop.

Receptacles must have a rating not less than the load they serve and when connected in branch circuits must be rated as follows:

15-amp circuits—not over 15-amp rating.

20-amp circuits—15- or 20-amp rating.

30-amp circuits—20- or 30-amp rating.

50-amp circuits—50-amp rating.

### Motors

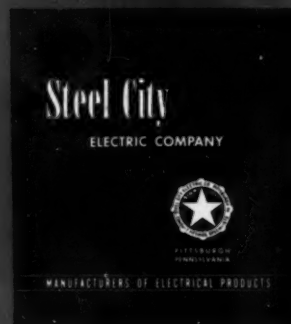
Motor and heating device outlets: The size and type of motor or heating device to be indicated on the plans is nearly always determined by specific units of mechanical equipment. Therefore, the discussion with respect to design procedure for power wiring must be based on the assumption that such equipment has been definitely selected before plans are prepared.

Outlet locations: In most cases the location of machinery such as pumps, compressors, elevators, blowers, etc., is fixed because of structural or other

**More Specifications on Page 248**

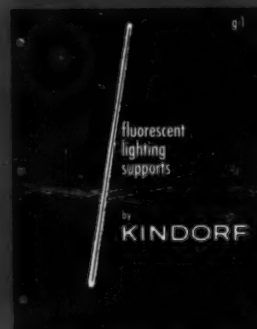
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**SUPRENE**

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## Electrical Specifications

important mechanical design features. Therefore, the motor or heating device location is largely dictated by the machinery location.

### Controllers

Controller locations: Particular care must be given to locate control equipment for maximum accessibility, to save steps, and to isolate it from mechanical injury or deterioration from dripping water, vapors, etc. To meet one or more of these conditions often necessitates a carefully chosen controller location at a remote out-of-danger place. Therefore one or more remote-control pushbutton stations are usually located nearby or upon each machine. In addition various auxiliary combinations of limiting switches or tripping devices may be selected or may already be included as integral machine equipment. The wiring plans should indicate clearly the locations of such controlling devices and the raceway routings to be followed when wiring connections are not already provided for them on the machine.

In grouping at one location two or more assemblies of controllers, disconnecting switches, resistors, and other auxiliary devices, show on wiring plans such details as are necessary to assure the fabrication of supporting frameworks and the proper alignment or positioning of raceways.

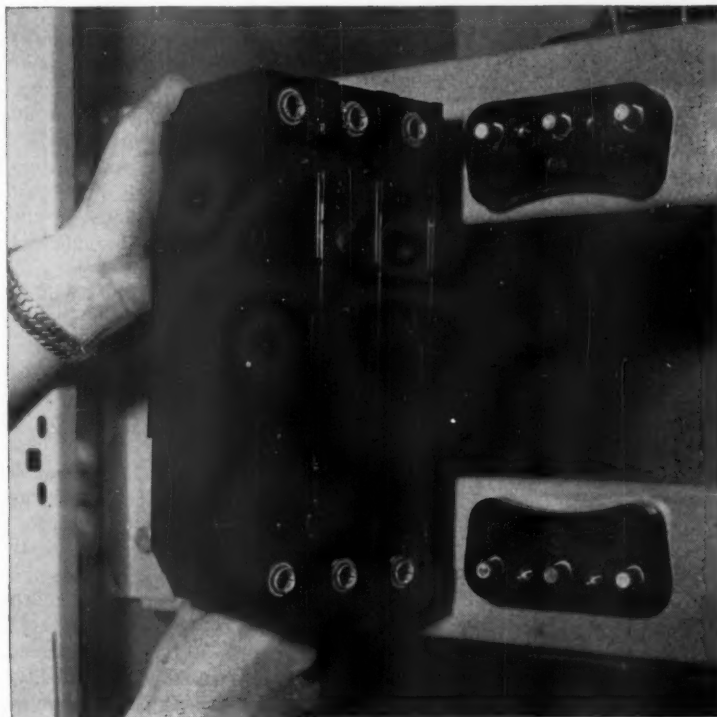
To determine the detailed requirements for motor controllers and their disconnecting means see Article 430 of the National Electrical Code. Where a motor controller is not located within sight of its motor, the controller must usually be capable of being locked in the open position. A manually operable switch designed to prevent the starting of a motor may be located within sight of remote controlled motors. This switch may be placed in the remote control circuit of the remote control switch or switches, or it may disconnect the motor branch circuit conductors.

Branch circuits: Wiring connections should indicate (1) whether raceways are to be run concealed or exposed between the motor or heating device and its control equipment, (2) whether run overboard or on the floor and (3)

More Specifications on Page 250



# Specify I-T-E Plug-In Mounting for Molded Case Circuit Breaker Switchboards



**IT'S EASY TO MOUNT** an I-T-E Molded Case Circuit Breaker when it is equipped with plug-in arrangement. Simply place the integral connectors over the stationary jacks and seat the breaker. It's safe too. All terminals are shielded to provide maximum protection to the worker.

Why settle for less! I-T-E Molded Case Circuit Breakers designed for plug-in mounting in switchboard applications provide features and advantages you get only in this modern, streamlined construction. Plug-in mounting is a time-proved method employed for many years in maritime switchgear, and is approved by Underwriters Laboratories Inc.

Here are some of the advantages of I-T-E Plug-In Mounting: *Added Safety.* Breaker terminals are concealed. No live parts exposed. *Flexibility.* Breaker ratings can easily be changed within their respective frame sizes. *Ease of Installation.* Breakers simply *plug in*. Molded supporting block assures automatic alignment.

Investigate I-T-E Plug-In Mounting before specifying your next molded case breaker switchboard. I-T-E plug-in molded case circuit breakers are available in ratings from 15 to 600 amp, up to 600 v a-c, up to 250 v d-c.

For details, contact your I-T-E representative or leading independent switchboard manufacturers. Or write Small Air Circuit Breaker Division, I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.



**FLEXIBILITY.** Withdraw one breaker, insert another of the same frame size with the desired continuous ampere rating. No wiring changes, no tools needed. All I-T-E Molded Case Circuit Breakers can be supplied with plug-in mounting arrangement.



**COMBINE TWO TYPES OF BREAKER** in the same switchboard. Large air circuit breaker pantograph mounted for horizontal drawout. Molded case circuit breakers plug in mounted for easy installation and replacement.



**I-T-E CIRCUIT BREAKER COMPANY • Small Air Circuit Breaker Division**


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This certification which appears on every box and reel of Bronco 60 Certified portable cable assures you that the protecting jacket contains a *bonus* quantity of Neoprene...65.46%! More Neoprene gives you greater oil-resistance, longer wear, more flexibility. No guesswork. No purchasing by faith alone. You *know* what you are getting. This certificate tells you *exactly* what...and how much. Be sure the wire you buy is *Certified*...and branded.



BRONCO 60 CERTIFIED is sold only through Electrical Wholesale Distributors and is manufactured by

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## Electrical Specifications

the exact location for terminating the raceway beside the motor.

Many motors and heating devices, as for printing press and laundry equipment, are mounted on machines with or without machine-mounted controllers. For such cases, particularly in concealed home-runs, the wiring plans should indicate the exact raceway termination at each machine. Where a machine is supplied with all its wiring installed by the manufacturer, state this condition, whereas the complete details of all wiring that is to be attached to machines by the wiring contractor should be indicated on the wiring plans.

For motors or heating devices that are located in areas having floors subject to seepage or prevalent moisture, the raceways may in some cases be routed overhead to avoid traps or water pockets.

Outlet and equipment location: The wiring plans must show outlet locations for exit and emergency lights to comply with the National Electrical Code, state and local fire or safety regulations. The locations of equipment for non-compulsory systems such as annunciators, loudspeakers, etc., should be chosen for ready access, step-savings, audibility or visibility. Transformers, charging devices, master instruments, relay panels, and junction or distributing cabinets should be located to permit easy access for maintenance.

Circuit routings should be shown on wiring plans to indicate outlet interconnection. If future extensions to the systems are contemplated, the careful routing and termination of initial circuits will greatly simplify such work later on. Unless circuit or cable runs are clearly determined on the wiring plans, frequent take-offs or multi-cable splices may be attempted which would tend to complicate maintenance.

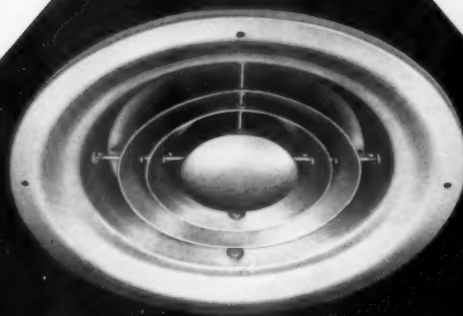
To simplify the routing and identification of auxiliary system conductors or cables, junction or terminal cabinets should be located at accessible points.

All branch circuits that supply power to auxiliary systems, such as for signaling transformers, battery chargers, converters, or for synchronous clock systems should be clearly identified within the panelboard to prevent

*More Specifications on Page 252*

unusual...  
ultra modern

new Beauty  
in a Baffle



## The new LOWELL STL series



**Lowell STL Baffles**, with "Floating Conical Action", have been engineered specifically for low ceiling areas where minimum projection is desired.

—And where the decor requires the ultimate in unusual, ultra-modern styling!

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## Electrical Specifications

them becoming disconnected by mis-  
take. This is most likely to occur at  
panelboards from which groups of  
lights are turned on and off by various  
persons.

### Panelboards

Lighting panelboards: The simplest  
form of panelboard is that providing  
one fuse or circuit breaker for each  
ungrounded circuit conductor, or, for  
the ordinary two-wire circuit, one per  
circuit. For circuits under 30-amp op-  
erating at not over 125 volts, plug  
fuses are generally preferred to car-  
tridge fuses as being easier to replace  
and occupying less space.

Branch circuit switch control at  
the panelboard is commonly provided  
in retail stores and in large spaces  
where it is convenient to have a single  
point of control, except where a more  
elaborate control system is called for,  
as in a theatre or other assembly hall.  
In an apartment building, hospital,  
or school building, local control by  
means of wall switches is necessary  
and circuit switches on panelboards  
are usually single-pole.

Branch circuit breakers provide  
both overcurrent protection and in-  
dividual circuit control.

Panelboards can be obtained with  
main fuses or a main circuit breaker.  
Such equipment is usually the most  
practical means of providing over-  
current protection for a panelboard  
where such protection is required. A  
main switch or circuit breaker may  
be useful if all circuits are to be con-  
trolled together; for example, a panel-  
board supplying show window lighting  
only.

Spare circuit equipment should be  
provided on every panelboard amount-  
ing to at least one spare circuit for  
each five circuits utilized in the  
original layout. Where the cabinet is  
built into the wall, provisions should  
be made for bringing this number of  
circuits out of the cabinet without  
channeling the finished wall. Such  
provision may consist of empty race-  
ways run up from the cabinet to  
covered outlet boxes located in the  
ceiling, or run down to boxes in the  
ceiling of the story below, or both;  
or by leaving space for two additional  
wires in each run from the panelboard  
to the first outlet.

More Specifications on Page 254





*On underground wiring at Chicago International Airport...*

REG. U.S. PAT. OFF.  
BRAND

## New SCOTCHCAST kit gives factory-type splices...on the job!

When Electrical Contractors, Inc., installed runway lighting at the Chicago International Airport, they used a completely new splicing method specified by Ralph H. Burke, Inc., Consulting Engineers—"SCOTCHCAST" Splicing Kit with "UNIPAK" Container. Workmen liked the ease of application, neatness of the finished job, simplicity of making a "factory-type" splice.

All the necessary materials for splicing a single-conductor cable (wire sizes 10 to 4 AWG) are con-

tained in the "SCOTCHCAST" Kit. A pocket knife is the only tool needed. Resin and activator are pre-measured in the "UNIPAK" Container—just mix and pour into mold. It quickly hardens into a solid mass of insulating resin completely encasing the splice. That's all there is to it!

"SCOTCHCAST" Kits will soon be available for splicing multi-conductor communication cables. For more information on this revolutionary splicing method (either single-conductor or multi-conductor cables), write Minnesota Mining and Manufacturing Company, Dept. EF-55, St. Paul 6, Minnesota.



*It's easy...and fast!*

1. **CONNECT** wires with "SCOTCHLOK." No tools needed. No heating.

2. **COVER** splice with mold. Pour in "SCOTCHCAST" after activating.

3. **COMPLETE** splice by breaking off pouring lips. Leave mold casing.



The term "SCOTCH" and the plaid design are registered trademarks for the more than 300 pressure-sensitive adhesive tapes made in U.S.A. by Minnesota Mining and Mfg. Co., St. Paul 6, Minn.—also makers of "SCOTCH" Brand Magnetic Tape, "Underscal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-slip Surfacing, "3M" Abrasives, "3M" Adhesives. General Export: 99 Park Ave., New York 16, New York. In Canada: P.O. Box 757, London, Ontario.



## G&W Oil Fuse Cutouts

### Protect men and equipment

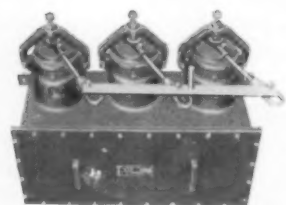


The type "FC" oil fuse cutout is primarily intended for fusing or switching primary circuits in underground or overhead installations. The cast steel tank (hermetically sealed and oil filled) provides maximum protection by safely withstanding the high pressures created when the high voltage fuse clears a heavy short circuit.

The switching contacts are beryllium copper. Fuse links are simple and inexpensive, easily replaceable in the carrier on the removable cover of the tank.

Welded steel boxes with cutouts on top, enclose connections to feed and load circuits.

The gang operating mechanism provides for three phase load break switching.



#### RATINGS

Size	Volts	Ampere
FC31	2,500	100
FC42	5,000	200
FC62	8,000	100

Bulletin CA52 gives data and prices. Write for copy or ask your representative.

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C541

## Electrical Specifications

Each of the following considerations shall be given due weight in determining the required number of panelboards and their location:

Good practice limits the number of branch circuits distributed from one location or panel to a maximum of 42.

No branch circuit run from the cabinet to the first outlet should exceed 100 ft.

Panelboards should always be accessible for the replacement of fuses or the resetting of circuit breakers. If circuit switches or circuit breakers are to be used for the control of lighting equipment, convenience of access for this purpose should also be considered.

Panelboard locations should be so chosen that the feeders will be as short as possible and may be brought to the panels with a minimum of expense for bends and offsets. It is difficult and often impossible to install large conduits concealed in the floor.

In a small building consisting of one story and a basement, a single panelboard located on the main floor may be sufficient. For larger buildings, one panelboard per floor may be considered the minimum.

**Lighting feeder capacity:** The minimum sizes of feeders to provide for carrying capacity are to be based upon a load of 1,000 watts for each 15-amp branch circuit installed, plus the total initial wattage of all heavy-duty lamp circuits, plus 500 watts for each spare circuit provided on the panelboard.

A demand factor as permitted by the National Electrical Code may be applied to the total wattage. This demand factor will be 100% for all retail stores and for small buildings of any occupancy.

Having determined the maximum demand in watts (total computed wattage x demand factor) for each feeder, the current per feeder is calculated as follows:

2-wire, 120-volt system

$$\frac{\text{Watts}}{120} = \text{amp.}$$

3-wire, 120-240-volt system

$$\frac{\text{Watts}}{240} = \text{amp.}$$

4-wire, 3-phase, 120-208-volt system

$$\frac{\text{Watts}}{360} = \text{amp.}$$

More Specifications on Page 256

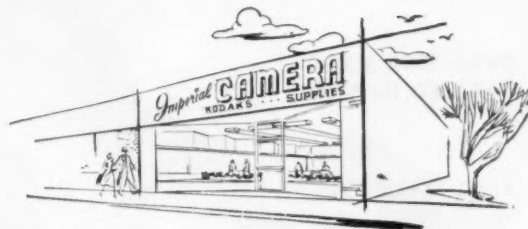
# MITCHELL Lighting chosen for the Imperial Camera Shop



HAROLD SOFFER, owner

Mr. Soffer's many years of experience as a store owner has made him well aware of the influence of proper store design on increased sales and properly directed store traffic.

"In my opinion," states Mr. Soffer, "the single most important element in a well-designed store is the lighting. Mitchell 'Polaris' fluorescent units were chosen for my store because of their modern design and their economical adaptation to pattern lighting installations. I have found that these fixtures provide a soft lighting effect with no disturbing glare upon glass showcases and displays."



## MITCHELL LIGHTS ANOTHER STORE

Imperial Camera Shop  
Berwyn, Illinois

Architect: Nerad and Carlson, Clarendon Hills, Illinois

Electrical Contractor: M. G. Electric, Cicero, Illinois

Distributor: Standard Electric Supply Co., Chicago

**INSTALLATION:** Flush-mounted MITCHELL "Polaris" two-lamp luminaires. Twelve incandescent downlights highlighting displays and major working areas. An average of 75 footcandles is maintained.



for better store lighting,  
**SPECIFY MITCHELL**

Write for complete details on MITCHELL  
store and other commercial lighting



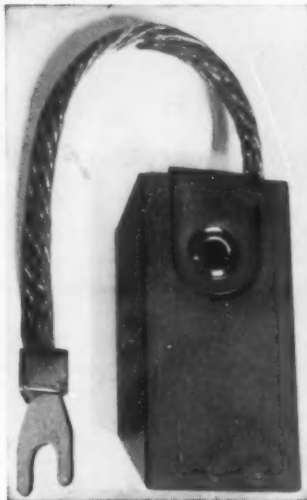
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## Electrical Specifications

**Voltage drop:** A voltage drop should not exceed 1% in the feeder system from the service entrance to any panelboard. Using the maximum demand amperes computed as explained above, the size of conductors required for 1% drop should be calculated and this size should be used if it is larger than the size required for carrying capacity.

Provide for future increase in feeder capacity. All branch circuit calculations are based upon a possible future increase of 50% in the load on 15 amp circuits and the substitution of lamps one size larger than the original lamps on heavy-duty lamp circuits. In order to make it possible to use this excess circuit capacity, provision must be made for a corresponding increase in the feeder capacity. This may be done (1) by installing oversize feeders originally, (2) by installing oversize conduits so that the original feeders may be replaced with feeders of larger size, or (3) by arranging the installation so that additional feeders can be installed at some future time at a minimum of expense.

(1) Where the conductor size required for the initial load is No. 8 or smaller, conductors large enough to provide for the future increase in load should be provided in the original installation. The additional cost of the larger conductors in such a case will be so small as to be unimportant.

(2) Up to a conductor size of about No. 1, conduits should be installed of sufficient size to contain feeder conductors of the size required for the future increase in loading. This will usually require, if the three-wire system is used, 1½-in. conduit for No. 6 or No. 4 conductors and 2-in. conduit for No. 2 or No. 1. Then when the need arises the original conductors can be withdrawn and replaced with conductors of larger size.

(3) Where the conductors are replaced as in (2), the original conductors have only a scrap value. To avoid this waste in the case of large cables, spare conduits may be installed so that the increased capacity may be provided by installing additional feeder cables. This method, however, requires that the original layout be planned with special care. It is not

*More Specifications on Page 258*



**\*Lighting that makes the nation's  
most important buildings come alive**



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Prowler & Sushan, architects-engineers;  
Lincraft Constr. Corp., gen'l contractor;  
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Hydrex Sealtest Ice Cream Co., L.I.C.  
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L & P Elec. Constr. Co., elec. contractor

Lever House, New York City  
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Here's the kind of *real portability* you've been looking for in a hydraulic conduit bender. And the *power* and *operating precision*, too.

One man can easily carry and operate the new GREENLEE No. 880 Hydraulic Bender — and pipe supports are designed to serve also as rollers for easy moving of the unit.

In developing the new *lightweight* GREENLEE No. 880 for bending pipe and conduit of 1/2" to 2" sizes, we took a tip from aircraft construction — used light, but strong, aluminum alloy for many parts. This means big savings in weight with no sacrifice in strength. In fact, there's more power and ruggedness here than you'll ever need.

Notice the separate two-speed hydraulic hand pump and ram, too, with special speed coupling on the

hose and pump for simplified handling, quick setup. Other advanced features include new design of the bending ram so that it will also fit GREENLEE thin-wall conduit, tubing, and busbar bending attachments.

With all the attachments for the No. 880, almost any type of bend can be made in all types of material within its size range. And a *complete 90° bend* can be made in conduit or pipe with one ram stroke! Designed for easy hand operation, the No. 880 can also be teamed with a GREENLEE Power Pump for fast production jobs. Get the complete story on this new bender. Write for Folder E-217.



GREENLEE TOOL CO., 1745 COLUMBIA AVE., ROCKFORD, ILL., U.S.A.

### Electrical Specifications

good practice to multiple two conductors of unequal size, hence the installation should be planned to utilize the additional feeder capacity by sectionalizing each panelboard or by changing the connections so as to supply certain panelboards by the new feeders.

**Power feeders:** Because of the varying factors in power feeder design as to routing, grouping of motors and voltage loss, five common methods of design or types of layout must be considered.

(1) A separate circuit may be run to each motor from a branch circuit distribution center.

(2) A feeder or sub-feeder may be carried around the building with branch circuits tapped to the feeder at various points, no branch circuit distribution center being used. Busbar distribution systems with taps to individual motors come within this group.

(3) A feeder or sub-feeder may be carried around the building with sub-feeder taps, having no individual overcurrent protection, carried direct to the disconnecting means or controller for each motor. In this case, the branch circuit overcurrent device is usually omitted and the motor branch circuit originates at the controller.

(4) A feeder or sub-feeder may be carried direct to the disconnecting means of controller for each one of the group of motors. Otherwise the layout is the same as in (3).

(5) A group of small motors, each having a full-load current rating not exceeding 6-amp, may be supplied by a 15-amp branch circuit or an appliance circuit. For conditions under which each of the foregoing types of layouts can be used and installation requirements applying in each case, see the National Electrical Code.

**Application of various types of layouts:** Type (1) can be used under any condition and is the type most commonly used. It is usually the preferable type for supplying the miscellaneous power loads in a commercial or public building, and is also common in industrial plants.

The use of types (2), which includes busbar distribution systems, (3) and (4) is chiefly in industrial plants where a large number of motors is used to drive individual machines.

*More Specifications on Page 260*

# SOLA *Lighting* TRANSFORMERS

SOLA ELECTRIC CO. • 4633 West 16th Street  
Chicago 50, Illinois • Bishop 2-1414

Continuing improvements and modifications in ballast design to meet changing lighting requirements prohibit presenting specific ballast data on this page. To get latest, complete data on fluorescent and mercury vapor ballasts, simply request the bulletins specified and ask that your name be placed on the Sola Electric Co. "Lighting" Mailing List.

## Fluorescent BALLASTS

All Sola Fluorescent Ballasts feature pressed-in core construction. This method results in uniformity of electrical characteristics. It also produces a core-and-coil assembly that is extremely quiet since vibration due to loose fitting parts is virtually eliminated. Sola ballasts are varnish impregnated under high vacuum and progressively compounded for quiet, reliable operation. They are designed and manufactured as premium quality ballasts.

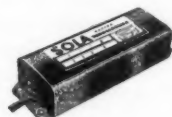
### Ballasts For Rapid-Start Lamps



- High Power Factor Ballasts for 60 cycle, two-lamp operation.
- Patented constant wattage circuit maintains light output constant within  $\pm 2\%$  over primary range of 106-130v.
- Peak to RMS ratio is only 1.51, better by 15% over maximum A.S.A. specifications.
- 300v from lamp to starting aid for positive starting with absolute safety.

WRITE FOR SPECIFICATION BULLETIN 17E-FL199

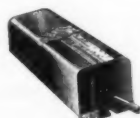
### Ballasts For Indoor Applications of Slimline and Instant-Starting Lamps



- High Power Factor Ballasts, 60 cycles, 106-130v.
- Sequenstart Ballasts for series-sequence operation, and Dynatran Ballasts for lead-lag operation of two instant-start hot cathode fluorescent lamps.
- Slimline Ballasts for operation of single instant-start hot cathode fluorescent lamps.

WRITE FOR SPECIFICATION BULLETIN 17E-FL186A

### Ballasts For Outdoor Applications of Slimline and Instant-Starting Lamps



- Specifically designed for outdoor non-weatherproof applications.
- Special low temperature capacitors and moisture-resistant wire leads.
- Positive starting and operating temperature characteristics ideal for wide range of conditions found in outdoor non-weatherproof use such as plastic signs, canopy fixtures and pylons.

WRITE FOR SPECIFICATION BULLETIN 17E-FL196A

### Ballasts For Cold Cathode Lamps



- High Power Factor Ballasts for 93 inch, 25mm. diameter cold cathode lamps operating at 106-130v., 60 cycles.
- All indoor types have constant wattage circuit. Outdoor non-weatherproof types with constant wattage or non-regulating circuit.
- Constant wattage types maintain light output within  $\pm 2.5\%$  with input variations as great as  $\pm 15\%$ . Operation maintained close to unity power factor, even when one lamp is inoperative on two-lamp parallel ballast.

WRITE FOR SPECIFICATION BULLETIN 17E-FL152A

## Mercury Vapor Lamp TRANSFORMERS

Constant wattage and conventional non-regulating mercury vapor lamp transformers are available for indoor and outdoor commercial and industrial applications. Constant wattage types regulate light output and lamp wattage regardless of line voltage fluctuations . . . eliminate need for primary taps . . . provide open and short circuit protection . . . extend lamp life.

### Transformers For Indoor Applications



- Constant wattage and conventional non-regulating types.
- Single-lamp or two-lamp operation of 400, 700 and 1,000 watt mercury vapor lamps.
- Constant wattage types maintain light output constant within  $\pm 2\%$  with line voltage variations as great as 25%.
- Compact, suitable for mounting in any manner.

WRITE FOR SPECIFICATION BULLETIN 17E-MV211 covering CW types and SPECIFICATION BULLETIN 17E-MV214 on non-regulating types.

### Transformers For Outdoor Applications



- For 1-400 Watt Type H1 Mercury Vapor Lamp.
- Constant wattage circuit maintains light output constant within  $\pm 2\%$  with line voltage variations as great as 25%.
- Outages virtually eliminated since primary voltage must drop below 70 volts before lamp extinguishes.
- Positive starting within primary ranges of 100/200- 130/260v without taps.

WRITE FOR SPECIFICATION BULLETIN 17E-MV208

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Send for your copy of Manual 101...  
"What You Should Know About Circuit Breakers".

HEINEMANN ELECTRIC CO., 132 PLUM STREET, TRENTON 2, N. J.

## Electrical Specifications

Type (2) requires for each motor a branch circuit overcurrent device. In type (3), no branch circuit overcurrent device is required, but the conductors from the sub-feeder to the controller must be larger than in type (2). The type (4) may show an economy in cost over either type (2) or type (3) if the sub-feeder can be economically brought to each controller.

Type (5) is merely a means of providing for small motors used with household and commercial appliances, by permitting them to be connected to lighting or appliance branch circuits. This is not to be considered as a type of layout having application in a factory.

For power applications in industrial plants, the first four types of layouts may be considered as on a par as regards serviceability. The choice between these types should be made on the basis of economy in cost of installation and flexibility; i.e., adaptability to changes in sizes and locations.

Voltage drop and carrying capacity of conductors: All conductors must have sufficient carrying capacity, according to the National Electrical Code requirements, and should also be of such size that the total voltage drop to any motor will not exceed 5%.

On any system operating at 208 volts or higher, it is recommended that the voltage drop in motor branch circuits should not exceed 1%, in which case a drop of 4% in the feeders is allowable. It will be found that with the minimum conductor sizes permitted by the National Code, the feeder voltage drop will exceed the 4% limit only where a feeder is unusually long. In any case where the drop will exceed 3%, the annual cost of the kilowatt-hours consumed in copper losses should be computed, and consideration should be given to the installation of larger conductors in order to reduce this loss.

In an industrial plant it is almost always desirable to install service and feeder conductors of larger sizes than are required for the initial load. Besides providing for load increases, the excess size will also have the advantage of reducing the copper loss.

Assemblies of externally operable switches or circuit breakers are adaptable to all installations, small or large.

**More Specifications on Page 262**

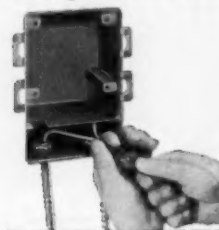


**THIS IS IT...** the  
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autotransformer-type  
light control!

NEW  
**LUXTROL**  
LIGHT CONTROL

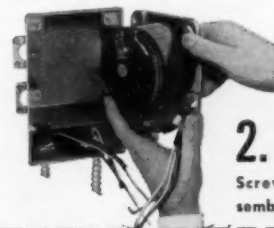


easy to install as an  
ordinary wallswitch . . .



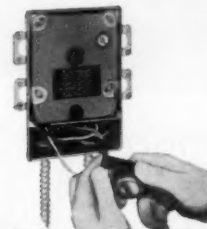
**1.**

Attach wallbox to  
studs . . . feed input  
and output load BX  
through knockouts.



**2.**

Screw control as-  
sembly to wallbox.



**3.**

Connect circuit  
leads to color-iden-  
tified control leads.



**4.**

Screw on face plate,  
attach dial, insert  
fuse . . . and new  
LUXTROL is ready  
for operation!

Here's the new light control that's making the wall-switch obsolete—not only in homes but in non-residential applications, too!

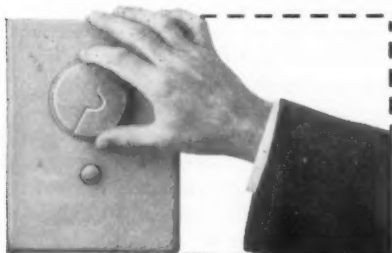
LUXTROL Light Control is an entirely new idea in modern interior lighting. It's an *autotransformer-type* light control. It produces at the turn of a dial any level of light from dark to full-bright . . . the *perfect* level of light for every occasion, every purpose.

LUXTROL is a soundly engineered, compact unit with brush and winding in constant contact. It has both fuse and thermal overload protection. It controls not

only incandescent lighting but fluorescent and cold-cathode as well. It operates smoothly, silently, safely . . . is approved by Underwriters' Laboratories.

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**You'll soon be getting calls for this completely new kind of modern light control. So make a date now for a personal demonstration. Call Western Union Operator 25 in your own city and ask for the name of your LUXTROL distributor.**



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- ✓ Trippers set or moved without removing dial—just set at proper timings and tighten tripper screws with fingers.
- ✓ Front mounted motor—easily checked thru window in motor cover—so mechanism need not be removed.

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## Electrical Specifications

Suitable provision should be made for the protection of feeders of increased size. All that is necessary is to provide space for the future installation of larger switches or circuit breakers, and means of making connections to the larger equipment without disturbing such of the original equipment as may be retained.

**Service:** The first step in determining the size of the service conductors and the capacity of the service equipment (switch and fuses, or circuit breaker) is to compute the total initial load by totalling the feeder loads. These should be the loads computed for the various feeders before any permissible demand factors less than 100% have been applied. Any power load should be segregated. By "power load" is meant any load consisting of motors or electrically heated equipment that is not to be supplied by "15-amp" or "appliance" circuits.

The demand factor permitted by the National Electrical Code should be applied to the total load other than power load. In most cases, no demand factor less than 100% should be applied to the power load. For a single service supplying a combined load of lighting and power, the total capacity will be the sum of the lighting load after applying the demand factor, and the power load.

**Provision for increased capacity:** The original installation should include service entrance conductors and service equipment having the required excess capacity in every case where the rating of the equipment, as thus determined, will not exceed 400-amp.

Where the calculated future load exceeds 400-amp, an individual study should be made of each case, considering each of the following:

(a) In any building having an expectant life of ten years or more, it is highly probable that some additional service capacity will be needed.

(b) In most cases, additional capacity can be provided only by tearing out and completely replacing the original service conductors and service equipment and the larger the service, the greater the expense involved.

(c) Considerable additional expense is involved in providing 50% excess capacity in the case of a heavy service and this is a non-productive investment until some part of the excess capacity is utilized.

# ELECTRICAL WIRES AND CABLES

The United States Rubber Company manufactures a complete line of electrical wires and cables. It has pioneered in the development and continued improvement of natural and synthetic rubber-insulated wire and cable, as well as plastic-insulated wire and cable. Selected items from the complete line are shown here. For further information refer to our nearest District Sales Office or Sales Agent shown below.

## PORTABLE CORDS AND CABLES

### U. S. ROYAL MASTER PORTABLE CORDS

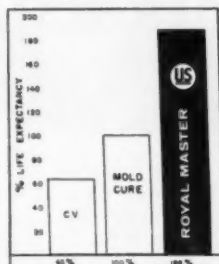


**Type SO—For heavy-duty service.** Neoprene jacket makes cords resistant to oil, sunlight, acids, alkalis, etc. Bare flexible annealed copper strands are cotton wound, insulated with heat-resistant natural rubber compound, twisted with suitable fillers, as required, and the assembly jacketed with 60% neoprene cured in lead. Listed and labeled by Underwriters' Laboratories, Inc., for 600-volt service at 60° C. U. S. Rubber Specification #705.

**Type SJO—For light-duty service.** Lead-cured neoprene jacket assures maximum protection. Similar to Type SO in construction. Listed and labeled by Underwriters' Laboratories, Inc., for 300-volt service at 60° C. U. S. Rubber Specification #715.

Extensive tests, both in the laboratory and in outside plant installations, show U. S. Royal Master gives...

- 33.3% greater heat resistance
- 55.7% greater impact resistance
- 53.8% greater abrasion resistance
- 30.6% greater resistance to cutting
- 110.3% greater resistance to tearing
- 21.2% greater breaking strength



Note that new U. S. Royal Master outlives the average molded cord almost 2 to 1 and the average short-lived continuous vulcanized cord 3 to 1.

- 23.3% greater oil resistance
  - 128.0% greater flexibility
  - 88% longer life
- ...than the average of all other molded cords—longer life than any other cord—surpassing even a hypothetical cord incorporating the best features of all competitive cords tested!

### U. S. ROYAL THREE-CONDUCTOR ROUND PORTABLE CABLE

#### Type W



Flexible coated annealed copper conductors separately insulated with colored performance grade compound, twisted together with rubber filler in the core and covered with reinforced 60% neoprene jacket cured in lead sheath, assuring maximum density and ruggedness. Designed for 600-volt service, 60° C. U. S. Rubber Specification #731.

### U. S. ROYAL GOLD FLUTED WELDING CABLE



A top-grade, extra-flexible cable engineered to give the longest possible life and durability. This cable is protected by a fluted Royal Gold 60% cured-in-lead rubber jacket so designed to allow cooler operation and a high degree of visibility while also offering added resistance to impact, abrasion and sunlight, etc. U. S. Rubber Specification #751.

## U. S. ALUMINUM WIRES AND CABLES



Aluminum conductors have been successfully used in weatherproof wires, rubber- and thermoplastic-insulated power and lighting wires, service entrance cable, aircraft wires.

Experience gained in testing and using these wires and cables, on the job and in the laboratory, has demonstrated that aluminum conductors are efficient and dependable in most electrical applications.

## POWER AND CONTROL CABLES



### U. S. Grizzly® Uskorona® Power Cable

For overhead and underground high-voltage power applications, control circuits and general purpose wiring up to 8,000 volts between phases. Light in weight, easy to install and join, resistant to oil, heat, sunlight, flame, acids, alkalis and corrosive chemicals.

- Oil base Uskorona-1,  
U. S. Rubber Specification #830
- Butyl Uskorona-2,  
U. S. Rubber Specification #831



### U. S. Laytex® Supervisory Control Cable

Used in systems for the selective control and automatic indication of remotely controlled units. Composed for solid annealed coated copper conductors individually insulated with 90% unmilled grainless rubber compound and covered with treated color-coded rayon braid. Required number of conductors (2 to 20) is cabled together with suitable treated filler, as necessary, and covered with compound-filled tape. Each layer of more than 8 conductors is covered with rubber-filled tape. The core thus formed is covered with neoprene jacket or lead alloy sheath. Suitable for 600-volt service. U. S. Rubber Specification #930.

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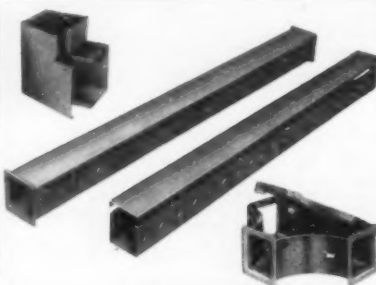
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SWITCH BOXES • OUTLET BOXES • BAR HANGERS



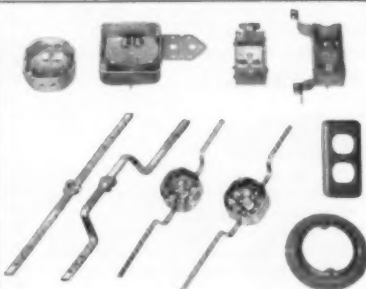
Fishin' for fish is fun! But when you're fishin' for extra profits on wiring installation jobs, the line to use to land your limit is the Keystone Quality Line. Because every item is *priced right* to help you "catch" more jobs. And every item is built right, too, to save you time and trouble... help you "net" bigger profits!

**KEYSTONE WIREWAYS** and Auxiliary Fittings have all the time-saving, money-saving features your customers want. They're quickly, easily installed, readily adaptable to any power distribution system. Available, too, in both flanged and flangeless styles and a wide range of sizes and lengths... from 2½" x 2½" x 1 ft. through 8" x 8" x 5 feet long.



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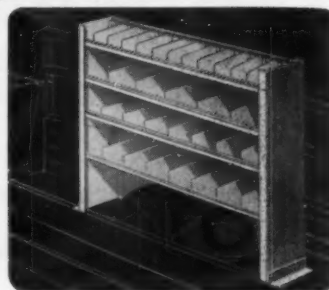
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## FASTEST . . .

because you can simultaneously pump and sight the job from any angle assure better bends. Can be hand operated or motor driven.



## LOW COST TOO!

Example: The S-30A kit for bending 1 to 2" rigid conduit contains powerful "Porto-Power" hydraulic jack and 9 bending attachments . . . costs only \$135.45

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## Labor costs cut more than 50%

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## with new *Speed-Line* system

PATENT PENDING

WITH  
*Speed-Line*

FIXTURES ARE  
PRE-ASSEMBLED  
AND PRE-WIRED  
AT FLOOR LEVEL  
no separate  
external mounting  
channel needed



No extra mounting channels are used with Garcy Speed-line . . . saves cost and bulk. Garcy "joiners" connect super-reinforced Garcy Fixtures into rigid, easily-handled units . . . straight as a die.

WITH  
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ENTIRE RUN IS  
RAISED TO CEILING  
AS A SINGLE UNIT  
. . . and uses  
fewer stem hangers



No straining at top of ladders. Simply hook Garcy Stem Hangers into hickies and then connect house wiring.

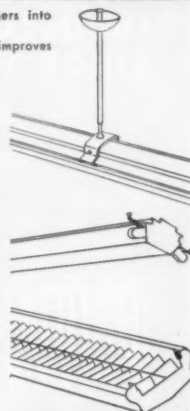
Here's another great saving! Fewer hangers are needed . . . improves appearance, saves cost of hangers and installing extra hickies.

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FIXTURES

What a boon to contractors! The savings in labor cost enable you to quote a lower total price . . . and still furnish the highest quality commercial fixture made, the Garcy VISUALIER. *Speed-line* installation techniques were specially developed to take full advantage of the Garcy VISUALIER'S unique design features. Separate, lightweight wireways are easiest to handle. The separate, one-piece shielding bodies may be left in cartons, safe from dust and damage, until the job is ready to lamp and light.

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has continuously variable range of 0-30,000 volts; capacity of 5 KVA.

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# BROOK MOTORS

HAVE TURNED THE WHEELS OF  
INDUSTRY NIGHT AND DAY  
SINCE 1904



1 H.P.  
To  
350 H.P.



WORLD'S MOST  
RESPECTED MOTOR

### BROOK MOTORS

#### WILL MORE THAN MEET YOUR REQUIREMENTS

. . . because they are designed for continuous operation in extreme temperatures or unfavorable conditions. Equal or better than NEMA specifications. Cost no more than standard motors—often less. Try a Brook on your next replacement. Splash-proof, totally enclosed non-ventilated, totally enclosed fan cooled, single-phase, open drip-proof, and pump motors. Send for Catalog.

### BROOK MOTOR CORPORATION

3567 W. PETERSON AVE., CHICAGO 45, ILL.

Fast delivery of all popular models. Brook motors are available from warehouses at Chicago, Jacksonville, Fla., Jersey City, N. J., Houston, Los Angeles, San Francisco, Seattle, Savannah, Ga., and other major distributing points.

A FOUR-IN-ONE TOOL FOR ELECTRICIANS

**SLITTER  
STRIPPER  
CUTTER  
SKINNER**



**B.E.P.**

# STRIPEX

The new STRIPEX is a wire Skinner; cable slitter; waste, wire, and cable cutter all-in-one tool! Made of steel, nickel plated. Replaceable blade. STRIPEX makes wiring easy and fast, slits and trims all the way into junction box.

### OTHER B.E.P. TOOLS

**B.E.P. PULLER REEL** . . . acts as a big handle, makes wire pulling easy!

**N.E.BEND Snake LEADER** . . . leads fish tape thru any number of bends, flips easily out of box to attach wires.

**OTHER B.E.P. PRODUCTS:** Fish Tape, BEP Puller, K.O. Box HANGER.

Order from your Electrical Wholesaler.



Only Y-ER EAS has all these features

- Creamy, non-corrosive lubricant. Never greasy or messy.
- Prevents sticking or setting. Specially helpful on saddles and turns.
- Does not run back on cables.
- Never harmful to hands or clothing.
- Permanently non-harmful to cables or conduit.

Write for  
descriptive  
booklet



GIVES THE SLIP TO-

Lead, Rubber, Braid or  
Synthetic Covered Cables

Improved Y-ER EAS tested and approved by the  
Underwriters' Laboratories, Inc.

AT ALL LEADING ELECTRICAL SUPPLY HOUSES



4145 F W. 150th St., Cleveland 11, Ohio

# DEPENDABLE

## Interior Communications & Fire Alarm Systems

NAME IT



MAKES IT

FOR

- HOSPITALS
- SCHOOLS
- APARTMENT HOUSES
- INDUSTRIAL PLANTS

the complete system ●  
easy to install ●  
built for service ●



**PRIVATE TELEPHONE SYSTEMS**  
SIMPLE AND MULTIPLE  
TELEPHONE SYSTEMS  
2-POINT TO 200-POINT SERVICE

*Couch* BULLETIN 121



**FIRE ALARM SYSTEMS**  
MANUAL AND AUTOMATIC  
FIRE ALARM SYSTEMS  
FOR CODED AND  
NON-CODED APPLICATIONS

*Couch* BULLETIN 124

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DATA SHEETS AND BULLETINS  
AVAILABLE UPON REQUEST.

**Built-in  
Dependability**

S. H. *Couch*

Company, Inc.

NORTH QUINCY 71, MASSACHUSETTS

# Speed service installations with M & W MAST KITS!

Complete package units  
ready to install

Fit 2" or 2½" conduit; strap or  
ring type brackets



No need to juggle the job to suit the fittings, when using M & W Service Entrance Mast Kits — you have the RIGHT fittings every time! Whether you select 2" or 2½" conduit, pipe ring or strap and lag screw installations, there's an M & W Kit EXACTLY RIGHT with every needed part included. You save time, materials and money... make a neater, more weather-tight installation, too!

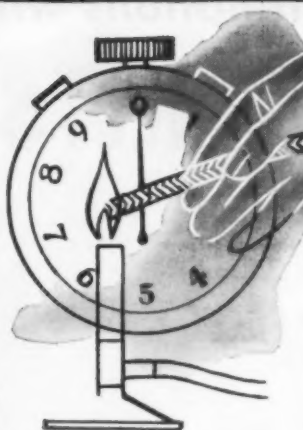
### EVERY MAST KIT INCLUDES:

- Entrance cap and threadless fittings for top and bottom of conduit.
- Galvanized roof flashing and cast aluminum storm collar.
- Conduit support of HDG malleable iron ring and ½ x 10 bolt (or pipe straps and lag screws).
- Wire holder with HDG malleable iron ring.

Prices and details available on a wide variety of kits to suit every need. Write for your copy of new Catalog No. 55—today!



*Electrical Fittings*  
**The M. & W. ELECTRIC MFG. CO., Inc.**  
EAST PALESTINE, OHIO



## SWITCHBOARD AVB — TA — SHFS CABLE and WIRE

for operating temperatures  
up to 194°F or 90°C; 600V.

Tinned copper conductor, solid or stranded, taped in varnished cambric or extruded in polyvinyl, then felted with carded asbestos; finished in durable cotton braid and flame-retarding paint.—After all this, it's ready for both Underwriters' bunsen-burner and Navy spark-gap tests—and for years of fixed or flexing service ahead!

**TRY to flame it!**

Write for stock-catalog, or about  
your special requirements.

## CONTINENTAL WIRE CORPORATION

Heat- and Moisture-Resistant  
Wires, Cables and Cords

PLANTS at YORK, PENNA.  
and WALLINGFORD, CONN.



Serving 600 to 5000 Volts,  
Sizes 18 AWG to 2,000,000 CM  
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Slash Motor Maintenance  
Speed Installation  
Increase Brush Life  
Cut Motor Down Time



## MULTIFLEX brushes with NEOPRENE pads

... really protect your motor and generator investments. Engineered for better contact and reduced vibrations, Helwig Multiflex brushes eliminate uneven wear and reduce circulating current. Get multiple brush operation without expensive changes. The key to longer commutator life is a quality brush designed to FIT, instead of a cut-down, so-called standard brush. Save production time and money with Helwig tailor-made brushes. Write for details on the Helwig brush inventory control plan.

**HELWIG CO.** CARBON  
PRODUCTS  
2502 N. 30th Street  
Milwaukee, Wisconsin

A GOOD NAME  
TO REMEMBER ...

# Arrolet

CORPORATION

Manufacturers of:

OUTLET BOXES AND COVERS • CEILING BAR  
BOXES AND BAR HANGERS • SWITCH BOXES  
• OVAL AND RECTANGULAR CONDUIT FIT-  
TINGS, COVERS AND GASKETS • FISH WIRE  
• FIBRE BUSHINGS • PIPE BENDERS • REDUC-  
ING BUSHINGS • REDUCING WASHERS •  
KNOCKOUT SEALS

SEE  
YOUR  
LOCAL  
SUPPLIER

SALES OFFICES  
and  
WAREHOUSE  
STOCKS

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After your prospect has been convinced by Display Advertising, he still must act. A personalized mailing piece, is a powerful action-getter. Send for our Industrial Direct Mail Catalogue, 150 lists available.

for Results



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**Quality  
Products**

- SPEED WIRING
- SAVE MATERIALS
- INSURE SAFETY
- IMMEDIATE DELIVERY
- TERRIFIC SAVINGS IN COST

**ONE DEPENDABLE  
SOURCE FOR ALL!**

### HI SCREW ANCHORS

save up to 70%  
on anchor costs



The "Hi" Sand-Scott Screw Anchor will outperform any anchor on the market—yet, it will cut your anchor costs as much as 70%! After making your own pull-out tests, you will be convinced that it is the most dependable anchor on the market. It can be used in any material you can drill a hole in and fastens wood, lag, sheet metal and hook and eye screws. Complete size range—No. 4 through No. 20 Screws plus 1/4" through 1/2" lag screws.

### WIRE CONNECTORS

Engineered for broader range of splices—streamlined to fit into shallow outlet boxes. Eleven sizes in Bakelite and Ceramic materials. Screw-On and Set-Screw types for two No. 18 up to three No. 10 solid or stranded wires—two sizes approved as pressure connectors for general use.



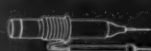
### PLASTIC STRAPS



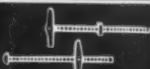
Available in two sizes for non-metallic cable . . . your choice of black or ivory color in both sizes. Rust and corrosion resistant—no insulation cutting—greater safety. Complies with REA. New ivory color perfect for NMC-UF cable.



WIRE STRIPPERS



VOLTAGE TESTERS



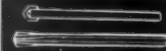
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PLASTIC SCREW ANCHORS



LEAD ANCHORS AND  
EXPANSION BOLTS



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DRILLS &  
HAND STAR DRILLS

**WRITE FOR FREE  
SAMPLE PACKETS**



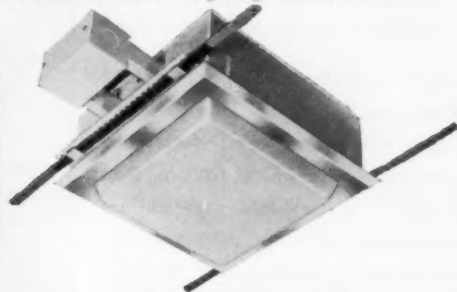
**HOLUB INDUSTRIES, INC.,**

442 ELM ST. • SYCAMORE, ILL.

# Specify Markstone...

to make  
**GOOD lighting jobs  
BETTER!**

*Two Examples from Markstone's Complete Line of  
Residential and Commercial Lighting Fixtures*



### NEW MARKSTONE "LUMI-DOME" INCANDESCENT RECESSED BOX

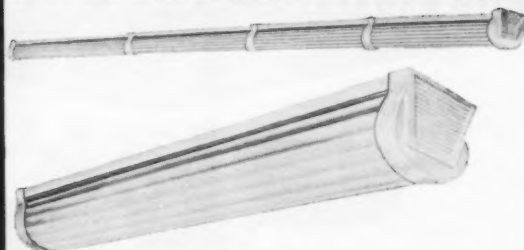
**WORLD'S EASIEST-INSTALLING** Recessed Box with exclusive, patented "TIME SAVER" Junction Box

A complete line of both PRE-WIRED and UNWIRED Boxes in all sizes—designed and engineered for maximum lighting efficiency and easy maintenance. All the features of the finest deluxe recessed lighting—yet competitively priced.

- Built-in patented "LUMI-DOME" Reflector utilizes entire reflecting surface of the box for critical light distribution.
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- Interchangeable Frame-and-Glass in a wide variety of finishes: Chrome, Brass, Copper, Painted, and Stainless Steel.
- Mounts in any type of Ceiling—no Plaster Frame or Framing-in required.

### MARKSTONE "LITELINE"

1- and 2-Lamp  
FULLY  
ENCLOSED  
FLUORESCENT  
FIXTURES



**COMPLETELY RE-ENGINEERED** for Maximum Lighting Efficiency with Minimum Glare Factor.

This versatile shielded lighting is easy to install and maintain . . . completely enclosed to keep out dust and bugs. In 1-lamp and 2-lamp styles, all popular sizes—both regular and rapid start.

- Ideal for Individual or Continuous Row, Surface or Suspension Mounting.
- Plastic Shield seals out dirt, debris, insects.
- Easy installation and maintenance.
- All die-formed steel construction.

**BIG NEW CATALOG** of MARKSTONE incandescent and fluorescent fixtures for every lighting purpose. Write today for your copy!



**MARKSTONE MANUFACTURING CO.**

Lighting for Modern Living  
2460 W. GEORGE STREET • CHICAGO 18, ILL.

# OVER- LOOKING A HAZARD?

You are if you are undersignalled!

All hazardous places or operations can't be eliminated, but their existence can be identified and pinpointed with an audible or visible warning signal.

A small investment in a FEDERAL Beacon Ray light, siren, horn or bell can save a life, avoid a painful injury or prevent a mechanical failure. One such saving, translated into dollars and cents may be the difference between business success and failure.

FEDERAL offers the most extensive variety of safety signals.

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FEDERAL Type A Siren



We have 'em!  
... 6 SIZES

**K&H**

**UNIVERSAL PRESSURE TYPE  
ADJUSTABLE LUGS**

One or two bolt holes

Wire sizes Nos. 14 to 1,000,000 CM. One-piece construction—easily installed. Body is well proportioned to withstand excessive use, with ample thread area. Makes tenacious grip on stranded conductors, forcing contact with each wire in strand, thereby insuring utmost in conductivity—bottom of tongue surface is ground. Not susceptible to release under vibration.

Write for dimensions and prices

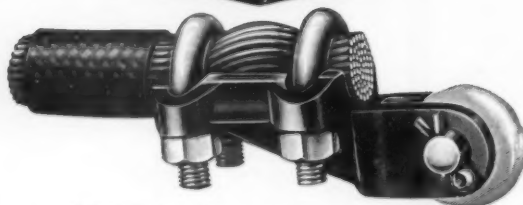
**KRUEGER & HUDEPOHL, INC.**

111 EAST THIRD ST. CINCINNATI 7 OHIO

LOCK CABLE SAFELY, SECURELY with—

# "EFFICIENCY" Cable Strain Clamps

without Strain or Damage



... withstands direct pull at 17,000 pounds

Efficiency Cable Strain Clamps lock cable safely and securely without possible strain or damage. "H" construction of clamps and high ridge across center of cable prevents cable from

slipping. Takes cable from 1/0 to 1,500,000 c. m. Three clamp sizes cover all cable sizes. Furnished with eye or clevis, for AC or DC service.

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*Efficiency*

**ELECTRIC AND MANUFACTURING CO.**

**EAST PALESTINE, OHIO**

MANUFACTURERS OF EFFICIENCY  
ELECTRICAL DEVICES FOR CONDUIT,  
WIRE AND CABLE SUSPENSION

**"EFFICIENCY" DEVICES FOR CONDUIT and CABLE SUSPENSION**

ORNAMENTAL  
LIGHTING  
FIXTURES OF TRUE  
DISTINCTION  
SPECIFY

# HERWIG

Exterior and interior fixtures in heavy cast iron, cast bronze, or cast aluminum. Over 200 attractive modern, colonial, and gothic designs. Herwig fixtures are in constant demand for:

- SCHOOLS
- HOMES
- CHURCHES
- LIBRARIES
- PUBLIC BUILDINGS



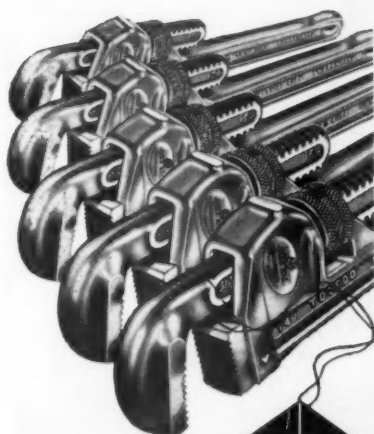
Herwig fixtures are constructed in metal this thick. They are built to last as long as the building.

Write for Catalog #50

**THE HERWIG COMPANY**

1757 Sedgewick Street, Chicago 14, Ill.

## ASK THE PIPE FITTER



### there is a difference in pipe tools!

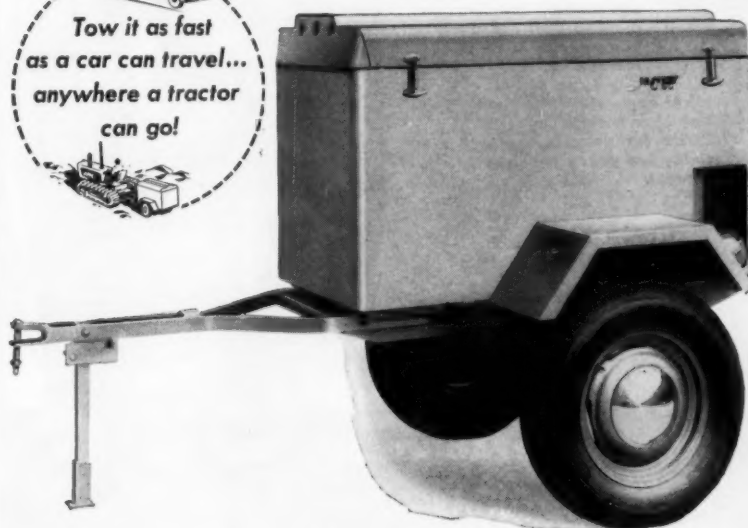
Good pipe tools mean longer service life and greater satisfaction on every job. Toledo unconditionally guarantees every pipe wrench it makes . . . your assurance of maximum service at lowest cost.

Single spring action gives quicker, easier setting on pipe surfaces. Replaceable jaws in every size from 6" to 48". Your supplier knows and stocks Toledo pipe wrenches, pipe cutters, pipe threaders and power machines. Next time try Toledo.

THE TOLEDO  
PIPE THREADING MACHINE  
COMPANY

BUILDERS OF THE WORLD'S FINEST PIPE TOOLS  
**TOLEDO**  
PIPE THREADERS • PIPE WRENCHES • PIPE MACHINES

## *NEW* Powerhouse on wheels!



Trailer-mounted 5 or 10KW

## ONAN Electric Plant!

**More plug-in power for construction work . . . higher mobility for emergency standby applications!** On contracting jobs where high-line power is not available, the Onan "CW" gives you abundant power for all your electric tools, equipment and lights. Now you can use one unit (in place of several smaller portable plants) reducing servicing time and maintenance costs.

Onan "CW" Electric Plants are unusually compact, quiet-running and economical to operate: weigh only half as much as water-cooled plants of the same capacity. Powered by Onan two-cylinder, suction-air-cooled gasoline engines built with massive, long-wearing parts for continuous, heavy-duty service. Fully-protected by heavy-gauge steel housing; stay on the job in any weather.

### Wide range of accessories make the "CW" more versatile

You can equip your "CW" Electric Plants for any type of portable service with a wide range of accessories including skid, battery rack, 9-gallon fuel tank, weather-proof housing, two-wheel trailer, or 4-wheel, rubber-tired dolly. Put one of these portable, high-capacity units on your job now!

*Onan builds electric plants for every need—400 to 100,000 watts*

*Write for folder A-362*



**D.W. ONAN & SONS INC.**

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THINK OF IT! 128 pages of tools, shop equipment, supplies, and insulating materials all especially selected with your needs in mind. If you repair, maintain or service any type of electrical apparatus, this manual is a natural for you. Write for your free copy today (on your letterhead, please).

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## JACKSON REFLECTORS



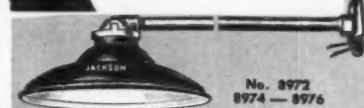
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No. 8972  
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Porcelain Enameled Yardlight

### JACKSON

ELECTRICAL COMPANY

900-910 W. Van Buren St.  
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## a new, superior system of CABLE and TUBING race ways GLOBE'S CABLE WAY

Easy to  
Install

Saves  
Time

Saves on  
Material

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No Main-  
tenance  
problem

A completely engineered system of cable ways, production produced and die formed for uniformity with up to twice the strength of ordinary trays, by actual laboratory tests. The universal splice plate joins all parts through the side channels only. All curved fittings are joined at the end of the radius (no tangent material is required) permitting continuous curves. This feature provides greater flexibility of application in tight places and creates an endless variety of combinations for a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings.

Comes in 6", 12", 18" and 24" widths, in standard 12' lengths to further speed up installation time. Cable way can be cut to length at any point—insides and bottom always smooth—all sections punched for easy installation—perfect fit at all times. Neat, clean and uniform in appearance.

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Distributors in all principal cities.  
Contact the Grip-Strut distributor under "Grating"  
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**Globetray**  
PAT. PENDING

THE GLOBE COMPANY  
Manufacturers Since 1914  
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THE GLOBE COMPANY  
CHICAGO 9, ILLINOIS

## Sound Powered TELEPHONES work in any emergency

because they  
NEED  
NO  
CURRENT



If everything else fails, these phones will still provide trouble-free performance over a distance of many miles. Speaking is activated solely by the sound energy of the voice while ringing is accomplished by a hand-driven magneto. For permanent installation on industrial projects or for temporary use on construction work where they can be moved as the job progresses.

### INDOOR AND OUTDOOR MODELS

In selective or common ringing and semi-selective or common talking. Cost of upkeep is negligible.

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TELEPHONE CO., INC.  
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**YOU'RE**  
**"Always Safe"**  
**with**  
**FARADAY**  
**PRODUCTS**

For over 75 years, Faraday has designed and produced visual and audible signals and complete signal systems of proven dependability. Whatever the signal requirement . . . bells, buzzers, chimes or annunciators . . . there's a Faraday unit or system that offers a quality product . . . with low cost installation . . . simplified maintenance and service for you and your customer. Increase your profits . . . sell and install FARADAY. Ask your distributor for information on Faraday's complete signal line.



Uni-pact Kodaire horns . . . specially designed to have a loud, penetrating, non-synchronous trumpet tone that is the most powerful of its type.



Uni-pact interchangeable signals . . . one adapter plate fits bells, buzzers, horns and chimes . . . for easy change and maintenance. Safety too . . . featuring electrically dead front adapter plate . . . no exposed terminals.



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**The PARAGON**  
**"Memory Master" time switch is**  
**100% Dependable**



**INSTANT CHECK** of motor operations through Moto-Vu operating window.

**INSTANT ADJUSTMENT**—add or remove quick-change dial trippers any time without removing dial.

**"TORSION-CLUTCH" DIAL DRIVE**—dial turns freely for manual check of "on-off" switch operations . . . yet has positive, no-slip drive.

**"QUICK-OUT MOVEMENT"** positively locks in case. Rattle-proof. Movement swings out when unlocked. No loose parts.

**SIMPLIFIED HOOK UP**—with new easy-access terminal block.

**FULL-DEPTH TERMINAL BLOCK INSULATOR PLATE.**



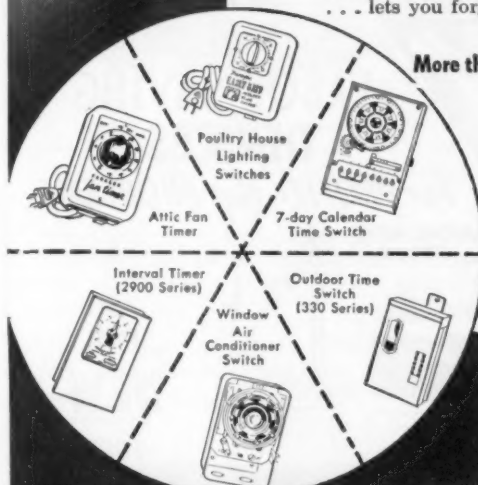
from \$10.50 list

**... used wherever a 24-hour ON-OFF time switch is needed**

Men in the electrical field are unanimous in their praise of the new 3000 Series Memory Master. It is 100% dependable for controlling "ON-OFF" operation of bill board lights, store illumination, poultry house lighting, stoker operation and hundreds of other plant applications. It's the switch that remembers . . . lets you forget.

**More than 40 time switches available**

Check Paragon's catalog the next time you need a time control. Paragon's complete line of 24-hour, 7-day, indoor and outdoor time switches — including industrial timers — makes your choice easy. For your personal copy of Paragon's latest catalog write Dept. 1614.

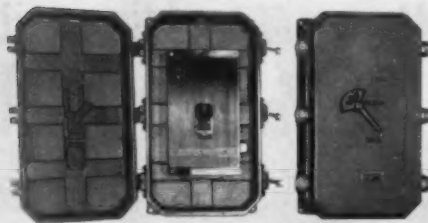


**PARAGON ELECTRIC COMPANY**  
TWO RIVERS, WISCONSIN



YOU'LL BE  
**GLAD**  
when you install  
**NELSON** water-  
tight and dust-  
tight air circuit  
breakers . . .

Inside and outside views: Nelson 225 ampere frame,  
3-pole, 600-volt breaker with 125-ampere trip rating.



The dependable, trouble-free operation of Nelson water-tight and dust-tight (NEMA IV & V) air circuit breakers, is sure to please you.

- 1) These thermal-type breakers provide dependable circuit protection.
- 2) Enclosures are of high tensile cast iron, produced in our own foundry.
- 3) Hinged covers are securely held in place by swing bolts. Neoprene gaskets keep out water and dust.
- 4) Breakers can be furnished in ratings up to and including 600 amperes, 600 volts.

• Write for Bulletin No. 1012.

**NELSON** *Electric* MANUFACTURING CO.

TULSA, OKLAHOMA

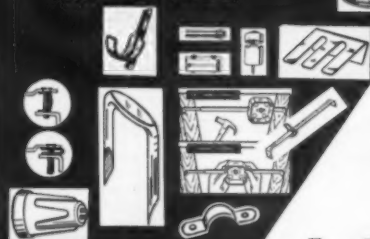
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TELEPHONE 2-5131

**Jiffy**

*Lint*

CONSTRUCTION  
MATERIALS



SPECIFY

**Jiffy**

LABOR-SAVING  
DEVICES

For PROFIT..Not PROBLEMS

PROFITABLE  
TOOLS



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FOR

**NEW**

1955  
CATALOG

The **Jiffy** Line  
SAVES TIME--TROUBLE AND MONEY  
Established 1913

**Clyde W. Lint**

2323 WEST 18th STREET  
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## MINERALLAC "PULL-IN" COMPOUND No. 100



LISTED  
and  
APPROVED  
by  
UNDERWRITERS  
LABORATORIES

**For Rubber, Synthetic, Plastic  
or Lead-Covered Wires or Cables**

Approved by Underwriters Laboratories for lubricating wires and cables to facilitate pulling them into conduits. Not injurious to wire or wire covers. Free of objectionable odors. White in color. Will not drip or run. Convenient pint, quart, 1/2 gal., gal. and 5 gal. cans. Available through your electrical jobber.

MINERALLAC ELECTRIC COMPANY  
25 North Peoria Street, Chicago 7, Illinois

**MINERALLAC**

PORTABLE  
A. C.  
POWER



MODEL 45 MGW4  
5 K.W.

**KATOLIGHT**  
POWER PLANTS  
*Wheel Mounted*  
for use anywhere!

Meet the need for portable power to operate time-saving A. C. electrical equipment such as saws, tools, heaters and lights. Nationally advertised, precision made, priced low. Many other portable models, 350 W. to 2500 W.

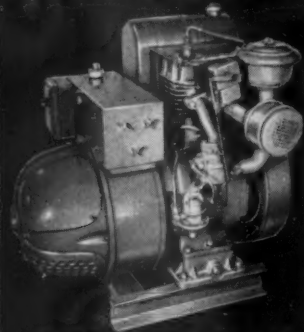
Also KATOLIGHT Power Plants to 50 K.W. for Continuous or Standby service. Generating equipment to 400 K.W.

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DETAILS

**Katolight** CORPORATION  
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***YOU can stand behind!***



**UNIVERSAL  
ELECTRIC PLANTS**

3800 watts, AC or DC, all controls. Fully modern.

## Properly Sized and Equipped for Every Need

*This year it's 40 years of continuous electric plant manufacturing for us! In terms of electric plants, the number is tens of thousands—models of all types, sizes, and for all applications.*

There's your assurance of a dependable product . . . an electric plant you can specify and install with complete confidence that it will serve faithfully.

Whatever and wherever your need for dependable electric power—standby-emergency, constant, or portable, you can fill it more satisfactorily from the Universal Line. It's "selective-sized"—with modern models in capacities from 250 watts to 25 kw, air-cooled, water-cooled, A.C. or D.C. Controls? Exactly what you require: manual to emergency-automatic starting.

As for prices, Universal offers the industry's lowest. See for yourself.

*Bring your files up to date: get our new specification chart and data folder of all air-cooled models. Also complete literature on water-cooled series. Write today.*

**UNIVERSAL MOTOR COMPANY**

Founded 1898

438 Universal Drive, Oshkosh, Wisconsin

*When You Sell  
**QUAD LIGHTING**  
You Sell Customer Satisfaction*



**QUAD**  
**GYMNASIUM**  
**LIGHTING**  
**UNITS**

• Here is a specially designed unit combining lighting efficiency with the ability to withstand shocks and rough treatment. Flush mounted this unit is ideal for installation in many types of modern construction where suspended ceilings are used.

The QUAD Gymnasium Lighting Unit has all of the features that make customers and profits. Installations have been made in various parts of the country, for combined gym and assembly halls, rinks, armories, and indoor arenas.

It is serviced from above or below ceiling—has detachable porcelain enameled reflector—angle iron plaster ring—is adjustable for variable ceiling thicknesses—has heavy wire guard and a dust tight glass cover is optional.

**QUADRANGLE MFG. CO.**

32 S. PEORIA ST.

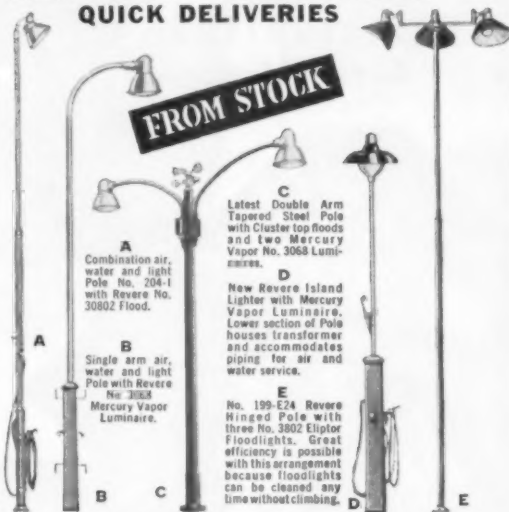
CHICAGO 7, ILL.

# Revere Poles

ELECTRIC MFG. CO. CHICAGO, ILL.

HINGED and RIGID TYPES

WIDE CHOICE • RIGHT CHOICE  
QUICK DELIVERIES



REVERE ELECTRIC MANUFACTURING CO. • 4017 BROADWAY • CHICAGO 40, ILL.  
Available in Canada thru Corvis Lighting, Ltd., Leaside, Toronto

THE COMPLETE LINE OF FLOODLIGHTS AND POLES FOR SERVICE STATION • SPORTS • AIRPORT • STREET • OUTDOOR THEATRE • MARINE AND INDUSTRIAL LIGHTING

FLOODLIGHTING  
IS AN ART  
WITH

Revere



CLOSED FLOODS  
FROM 150 TO 5000  
WATTS



FAMOUS ELIPTOR  
300 TO 1500 WATT



ENDOVAL & STAR-  
LUX MERCURY  
LUMINAIRES

HINGED  
POLES  
CREATED  
BY  
REVERE



HINGED AND RIGID  
FLOODLIGHT POLES

## MEGOHMER INSULATION TESTERS

### MODEL B-7

Precision Ohmmeter-Megohmmeter. 2 Megohm Ranges: 0-20, 0-200 Megohms. 2 Ohm Ranges: 0-200, 0-20,000 Ohms. 2 Test Potentials: 250 and 500 Volts DC. Battery—vibrator type.

Bulletin 440.

### "MINOR"

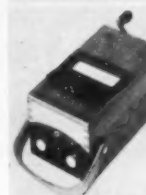
Dwarf Sizes: 3 lbs. with variable pressure DC Generator. 500 Volts D.C. Range: 0-10 or 0-20 or 0-50 Megohms.

Bulletin 450.

### "MAJOR"

Crank Type with Constant Pressure. DC Generator 500 Volts. Range: 0-50 Megohms with extra Ohm scale 0-30 or 0-10,000 ohms.

Bulletin 465.



HERMAN H. STICHT CO., INC.  
27 PARK PLACE, NEW YORK 7, N. Y.

## New Sherman Crimp-Type TERMINAL LUGS



SIZES AVAILABLE

No.	Amp. Cap. N. B. C.	Max. B & S (A. W. G.) Stranded Wire
ST8	35	8
ST6	50	6
ST4	70	4
ST2	90	2
ST0	125	0
ST2/0	150	00
ST3/0	175	000
ST4/0	225	0000

### For Commercial Wire

- Wire sizes 8 through 4/0
- Approved by Underwriter's Laboratories when used with the Sherman Crimping Tool.
- Highest grade electrolytic copper, plainly marked with wire size and ampere rating.
- Completely seamless — made under exclusive Sherman patents.

Investigate Sherman Crimp-Type Terminal Lugs — They're Fast, Positive and Economical — Write for Bulletin.



H.B. Sherman  
MANUFACTURING CO.  
BATTLE CREEK, MICH.

ELECTRICAL FITTINGS  
FOR WIRE AND CABLE

## modern FOR EVERY LIGHTING NEED...



### COMMERCIAL

The COMMISSIONER, designed to give high efficiency... easy to install, with low maintenance cost.



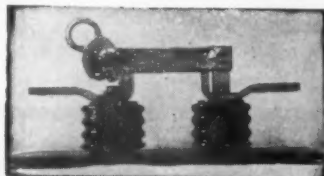
### INDUSTRIAL

Tough, durable fixtures that give abundant glare-free light. Modern's Industrials give years of trouble-free service.

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OR  
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modern LIGHT CO.  
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## DISCONNECTING SWITCHES

Hook-Stick Operated by

## POWERCRAFT

• Powercraft Disconnects are built of bus bar copper for uniformly high conductivity in the current carrying path. Silver ball contacts assure low temperature rise. Simple firm locks.

### Other POWERCRAFT Products

• Bus Clamps • Indoor and Outdoor Bus Supports • Power Connectors • Pipe Frame Fittings for 1½" I. P. S. Pipe • Clamp Insulator Supports

Write for your copy of our new catalog. A few territories still open to qualified manufacturers' agents.

### Powercraft Corporation

2215 DeKalb St., St. Louis 4, Mo.  
Phone PRospect 6-4532 Since 1932

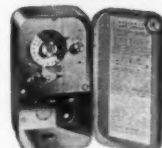
## Why RELIANCE TIME SWITCHES Are OUTSTANDING VALUES . . .



Heavy Duty "Badger"



Versatile Model "W"



Low Cost Model "400"

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### THEY ARE GUARANTEED

Every Reliance time switch you sell is guaranteed for 18 months. This complete warranty includes both materials and craftsmanship.

### ACCURATELY RATED

Reliance time switches are built in capacities conforming with recommended NEMA ratings and are listed by Underwriters' Laboratories, Inc.

### QUALITY CONSTRUCTION

- Minimum of working parts
- Heavy, brass cut gears and steel pinions
- Ground and polished steel shafts
- Non-arcing, pit-resistant contacts
- Expert workmanship

RELiance AUTOMATIC LIGHTING CO.  
1937 MEAD ST. RACINE, WIS.

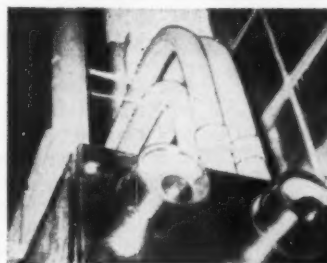
## RELIANCE TIME SWITCHES



Pat. No.  
2632356

**NO BEND • NO SQUASH  
A MUST for Electrical Men**  
• Engineered to withstand punishment—Contractors, Refrigerator Men, and Plumbers save time, labor and material with these strong, rugged THIEL Staples. The greatest improvement in BX Staples in 30 years. Another MUST for electrical men—Thiel's Easy-Drive "Nail It" and Easy-On Straps.

• Sold by Leading Electrical Wholesalers—  
write for information on open territories.  
**THIEL TOOL & ENGINEERING CO., INC.**  
1417 N. Market St. • St. Louis 6, Mo.



By making 12 90° bends in 3" conduit with a TAL ONE-SHOT BENDER instead of using elbows and couplings, time was cut from 59 to 39 hours . . . \$134 was saved on labor and material on installation of a 250 hp, 220 volt, 3-phase air compressor in the shop of the Diamond T Motor Car Co., Chicago. This was possible only because a TAL ONE-SHOT completes bends in one setting—no shifting of pipe is necessary!

• 20 hours in time  
• \$64 in materials  
**SAVED ON ONE JOB  
WITH A TAL  
PORTABLE BENDER**

by the  
Johnson Electric Co.  
Chicago



### COMPLETE LINE OF BENDERS

- For pipe up to 8"
- For copper and thinwall tubing.
- 6-Way Hickeys — do what others can't do.

## TAL 6-WAY BENDER

WITH

- EXTRA STUB HOLE
- SIX WAY NON-SLIP SHORT BENDING JAWS for close quarters or open slab work. Non-Slip, Accurate, Rapid and Easy Bending.
- SAFETY NECK for SURE GRIP.



Sizes	Price Each	Pkg. Price of Ten
½"	\$3.70	\$3.10 ea.
¾"	4.65	3.90 ea.
1"	7.95	6.65 ea.

**TAL BENDER, INC.**  
DEPT. 21 • MILWAUKEE 2, WISCONSIN



Complete coverage from  
one source . . .

**No. 3651 RANGE AND POWER RECEPTACLE, FLUSH MOUNTING.** Heavy Bakelite with Patented Swing-away Terminals that prevent dropping or losing of parts. Allows easy one-hand wiring. Polarized for Range and Power Cords. Designed for 4" or 4 11/16" square box. 50 Amps. - 250 V.

**No. 3550 3-WIRE RANGE AND POWER CORDSET.** All Rubber, 36" Long. Blades are Welded to Wire. No solder is used. One piece molded rubber cap. Includes cable clamp. 50 Amps. - 250 V.

**No. 3601-558G STEEL RANGE RECEPTACLE PLATE, SPRAYED BRASS FINISH.** Grounded.

**No. 3650 RANGE AND POWER RECEPTACLE, SURFACE MOUNTING.** Heavy Bakelite with Patented Swing-away Terminals that prevent dropping or losing parts. Allows easy one-hand wiring. Polarized for Range and Power Cords. Heavy steel back plate has knockouts for 3/4", 1", 1 1/4" conduit. Has built-in cable clamp for back or bottom wiring. Complete with mounting screws. 50 Amps. - 250 V.

**50 YEARS**

**CIRCLE F MFG CO.**  
TRENTON 4, NEW JERSEY

# Motor Shops

## Test Panel Speeds Equipment Repair

An electrical test panel devised by B. Eichwald & Co., New York, has proved its value to shop repair work through constant use for laboratory-type tests on a great variety of electrical equipment.

Primary feed to the panel is 3-phase, 4-wire, 120/208-volt. Voltages of 1 to 208 volts may be obtained from the line through variable transformers, while higher voltages of 500 to 5000 volts are available from built-in transformers. Voltmeters and ammeters provide an immediate check of equipment on test; one ammeter and one voltmeter may be switched out of the test board circuit by means of a DPDT switch for any job that requires an isolated meter. A built-in meter multiplier is available for checking dc voltages of 1 to 250 volts.

Capacitors of 40 to 400 mf may be measured directly on a built-in bridge. Sizes of capacitors required for single-phase capacitor motors may be determined by means of a meter-switch arrangement which permits capacitors of various sizes to be switched in or out of motor starter circuits.

A multiple series lamp arrangement is provided for testing lamps and fuses and for probing motor windings, relays, heaters, etc. A tapped transformer supplying 2½, 5, 6, 12 and 24 volts is equipped with a bell and buzzer for probing low-voltage windings and for making continuity checks. Single-

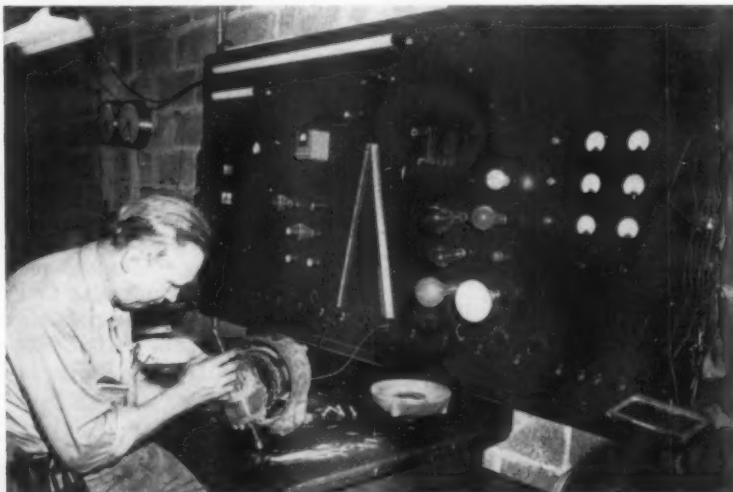
2- and 3-phase Twist-Lock and pin plug receptacles may be switched for series or across-the-line operation.

The test board is energized with a magnetic switch operated by a specially designed foot treadle which keeps the foot only ¼ in. from the floor, leaving both hands free. The entire test board is dead whenever the foot is removed from the treadle, eliminating the possibility of the operator moving off and leaving live wires or equipment.

## Scrap Strap Makes Armature Cradle

Small armatures are securely and quickly cradled on benches of the Industrial Electric Company of York, Pa., by shop-made devices that are as easy to form as the letters U and M. In fact, those two letters, formed from 1½-in. scrap steel, are the essential parts of the cradle, because the inverted U strap is threaded to receive a long-shafted locking bolt, while the M-shaped section serves as the cradle rest for the armature. These two sections, welded to a flat bed plate as indicated in the accompanying photo, are then secured to the bench top by means of bolts that pass through both the base plate and bench top.

The long bolt passing through the upper section is fitted with a thumb screw to facilitate turning, and with a ball-bearing shoe at the bottom to prevent scoring the armature being held.



**TEST PANEL** with wide variety of voltages, equipment and circuit arrangements accommodates all types of electrical equipment.

**Wagner®**  
ELECTRIC MOTORS  
...the choice of leaders  
in industry

# NEW!

## Wagner Type DP Motors

*Doubly Protected*



\* Wagner Type DP Motors are protected by rugged, corrosion-resistant cast iron frames, smoothly rounded so that no moisture can collect on them. Motor feet are cast as an integral part of the frame for maximum strength and rigidity.

\* Enclosures are drip-proof plus! Air intakes are located at the bottom of the endplates — air outlets are located at the base of the frame, one on each side. Specially designed baffles provide protection for the stator windings.

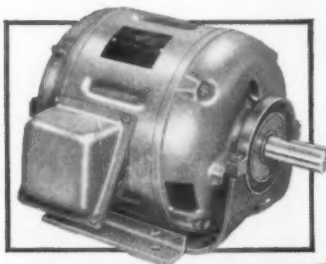
The Wagner line of polyphase, drip-proof general purpose motors—rated to the new NEMA Standards—pack more power into smaller frames, but give you the same high Wagner Quality and long life performance that have made Wagner Motors “the choice of leaders in industry” for many, many years. These new Wagner Motors are fully protected in the ball bearing models. Their construction makes them completely drip-proof — and virtually splash-proof. The extra large, diagonally split conduit box makes wiring easy. Smaller size

and lighter weight means more economical handling and installation.

These new rated Wagner Motors retain the features desired by plant engineers and maintenance men. They will operate for years without regreasing. But... when lubrication is necessary or desirable, you *can* lubricate these motors because they are provided with two lubrication openings.

Bulletin MU-202 gives full information—write for your copy today.

### AVAILABLE WITH RESILIENT MOUNTING —SLEEVE BEARINGS UP THROUGH 5 HP.



These Wagner standard motors, in ratings up through 5 horsepower, can be used for specialized applications because they are available in sleeve bearing models with endplates that will take resilient mounts.

You can look to Wagner for a complete line of standard motors for specialized applications. The wide range of types and sizes permit the selection of a standard motor for almost any need.



**Wagner Electric Corporation**  
6413 Plymouth Ave., St. Louis 14, Mo., U. S. A.

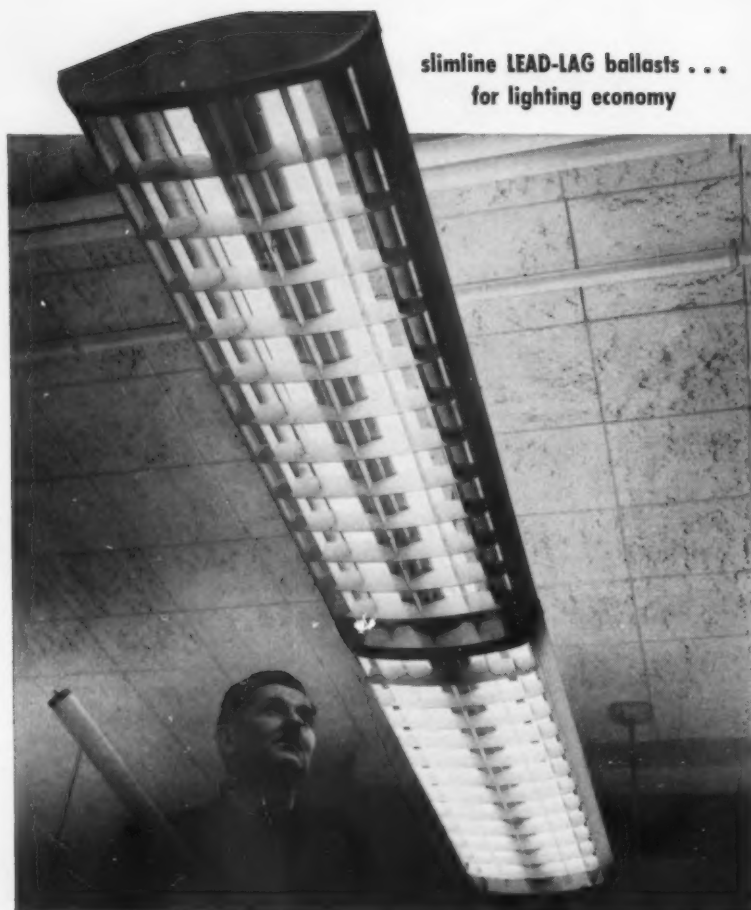
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

M55-6

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

ELECTRICAL CONSTRUCTION AND MAINTENANCE . . . MAY, 1955

279



slimline LEAD-LAG ballasts . . .  
for lighting economy

Above fixture equipped with series ballast. Lamp on right has burned out causing left lamp to burn at reduced light output. With LEAD-LAG ballast, left lamp would burn at full output.

## Are you throwing out good lamps?

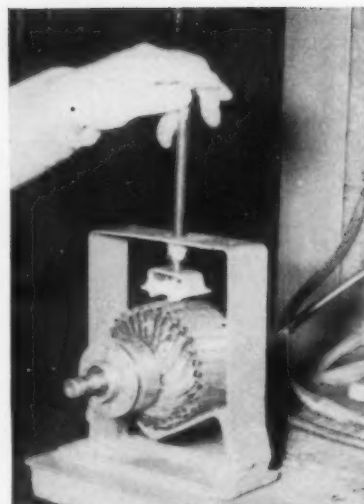
Slimline LEAD-LAG ballasts can put a stop to this waste immediately. It's as simple as this: Remember the old string of Christmas tree bulbs—when one failed the whole string went out? But now the new ones eliminate wasted energy and guessing—when a bulb fails the others remain burning. The same principle holds true on fluorescent lamps that are equipped with Westinghouse slimline LEAD-LAG ballasts.

It will pay you to have your maintenance people specify Westinghouse slimline LEAD-LAG ballasts—the savings in labor and lamp replacement are substantial.

More information? Call your nearest Westinghouse representative, or write Westinghouse Electric Corporation, Lighting Division, Edgewater Park, Cleveland, Ohio.

J-04378

YOU CAN BE **SURE**...IF IT'S  
**Westinghouse**



**A TWIST OF THE WRIST** and the small armature motor is securely cradled in this simply-constructed scrap-strap device designed and fabricated in the shop of the Industrial Electric Company of York, Pa.

Several of these devices, constructed in various sizes, are of definite assistance in small motor repair work, according to shop foreman David Miller.

## Folding Coil Rack

Coil racks that can be folded snugly against the shop wall when not in use, or swung outwards when coils are coming off the winding machine, can be simply constructed from sections of 1-in. pipe, as they were made by the standard Motor Repair Company of Linden, N. J. As indicated in the photo, the vertical members are attached to the wall by means of pipe tees, while the horizontal members are similarly attached to the main stem.



**NO FLOOR SPACE** is required for these folding coil racks which were made in the Standard Motor Repair shop in Linden, N. J.



# NEW *Big Beam* AUTOMATIC EMERGENCY LIGHT

Model  
2ATW



It's the most COMPLETELY DEPENDABLE emergency light ever built! When regular lights fail... this new Big Beam turns on instantly — provides hours of illumination. The battery is charged to capacity at all times by an enclosed trickle charger. Your customers deserve Big Beam quality and dependability.

## *Big Beam* PORTABLE ELECTRIC HAND LAMPS

Model 166

This sealed beam model is one of many types of Big Beam portable electric hand lamps used in thousands of plants and warehouses throughout the country. Learn more about the complete Big Beam line.



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1035 West Hubbard St., Chicago 22, Illinois  
In Canada: Bernard Marks & Co., Ltd.  
459 Church Street, Toronto 5, Canada.

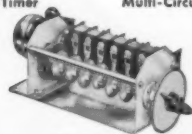
## ZENITH AUTOMATIC CONTROLS are engineered to give you greater accuracy!



Interval Timer



Multi-Circuit Timer



Process Timer

Rely on field-proved ZENITH Controls for trouble-free, maintenance-free operation... long-lasting performance and accuracy.

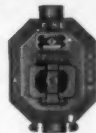
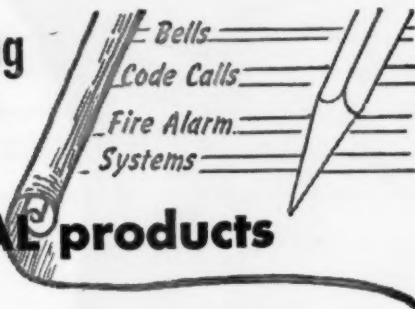
The ZENITH line includes: Magnetic Contactors; Remote Control, Reset, Interval and Process Timers; gearless, clutchless Impulse Timers, Program Clocks... and special units to order.

Write Today for Latest ZENITH Bulletin

See classified telephone directory for name of local distributor.

**ZENITH ELECTRIC CO.**  
155 W. WALTON ST., CHICAGO 10, ILLINOIS

## You are specifying RELIABILITY when you select SIGNAL products



Fire Alarm Systems  
(Interior & Exterior)



Signal Devices



Code Call Systems

You can expect complete reliability from products engineered and manufactured by Signal Engineering & Mfg. Company, originators of A-C Fire Alarm Systems and the Underdome Bell. Some of the SIGNAL products of special interest to the building industry are:

Interior Fire Alarm Systems (coded and non-coded types) complete with wall boxes, control panels and signal devices

Single-stroke and vibrating bells in various sizes; chimes, cow bells and horns

Code Call Systems for instant communication with individuals away from desks or benches.

Write for  
Catalogs FSC-3

*Wheelock*

**SIGNAL**  
ENGINEERING & MFG. CO.  
LIND BRANCH NEW JERSEY

Engineering  
Representatives  
in Principal Cities.

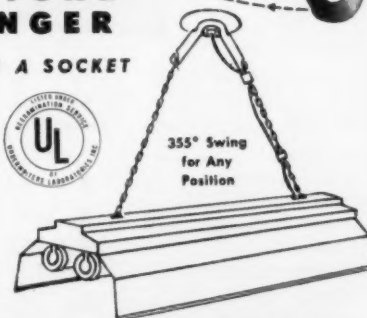
## Now... align fixtures INSTANTLY!



## "Friction Set" FIXTURE HANGER

• EASY AS PUTTING A BULB IN A SOCKET

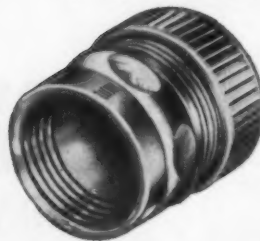
A twist of the wrist turns fixture to any alignment — after hanger has been attached to any 3/4" or 4" outlet. Base and receptacle are stationary — arms revolve. Once lined up, exclusive FRICTION RING holds fixture firmly in selected position. Receptacle is mounted at factory — ready for use. Complete with two 5' chains, hooks and cord clips. Order from your Simplet Distributor or write for information and prices now.



## SIMPLET ELECTRIC COMPANY

A Wholly Owned Subsidiary of IDEAL INDUSTRIES, Inc.  
1041 PARK AVE., SYCAMORE, ILLINOIS

VERSATILE



# midwest "U COM" COUPLING

## APPLICATION:

For coupling thin wall to rigid conduit and/or any fitting threaded for a locknut. That means thin wall to rigid conduit, flexible steel conduit, armored cable.

## PRODUCT DETAIL:

Fitting body is seamless steel, drawn with precision dies for controlled uniformity. Hexagon center area for holding when fitting is installed. Cadmium plated for protection against corrosion. Size range:  $\frac{1}{2}$ " -  $\frac{3}{4}$ " - 1" thin wall to  $\frac{3}{8}$ " -  $\frac{1}{2}$ " -  $\frac{3}{4}$ " - 1" various conduit and cables.

● Another Midwest quality fitting. "Quality" is just a condensed way of saying: "Getting the total job done — right — with the most inexpensive combination of material and man hours." Engineering and producing quality fittings to meet the highest standards of electrical wiring installations, is our objective at Midwest.



**Midwest Electric Mfg. Company**

MANUFACTURERS OF ELECTRICAL WIRING PRODUCTS

1639 W. WALNUT STREET  
Chicago 12, Illinois

# Product News



**Control System (1)**

A central control system has been developed to follow preset programs and automatically switch on or off up to 40 groups of remote operations, each on its own time schedule. Described as an "electronic supervisor", the new system provides remote control of facilities such as lights, motors and valves within a plant or institution. The system operates by carrier current signals transmitted over existing electrical circuits. No transmission wire is required. The system can cover a single building or several buildings scattered over many acres. The various control signals originate in a flexible central operations panel, where complex scheduling and programming of signals can be easily set up. The system may also incorporate automatically synchronized clocks, and audible signals can be readily controlled without special wiring. The control system can provide signal injection into distribution systems rated from 110 volts to 13,800 volts.

*International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.*



**Load Center (2)**

A new 12-circuit load center with a 100-amp main breaker wired into the box, for use in homes, shops, garages, and commercial and office buildings. Rated for use with 100-amp, 120/240-volt ac, single-phase, 3-wire service. It can ac-

commodate 12 single-pole breakers, 6 double-pole breakers or any combination of both for branch circuit protection. The wired-in main breaker is a heavy duty E frame circuit breaker rated 100 amps. This protects the line wires from short circuits and heavy overloads. It also serves as a main disconnect for all circuits. Listed by Underwriters' Laboratories, the new combination load center is available in a general purpose enclosure for surface or flush mounting. A front with full length door is standard equipment. And to make the device tamper-proof, an optional lock kit for field installation is available. Construction features include snap-in spring-mounted interiors, plug-in breaker connections, silver-plated copper for current-carrying parts and Bonderite finish on box and front.

*Trumbull Components Department, General Electric Company, Plainville, Conn.*



**Switchboards (3)**

A new line of QMB plug-in fusible "power-style" switchboards. They feature rugged, quick-make, quick-break fusible-switches furnished in all standard ratings from 30 amps to 600 amps, 2- and 3-pole. They are horsepower rated for both standard NEC and dual element fuses and are available for use on 250 volts ac or dc and 600 volts ac. Switchboards are designed for use in a wide range of commercial and industrial applications where grouping of power distribution equipment is desirable. Flexible design enables the QMB fusible section to be combined with large air circuit breakers, metering devices, or other auxiliary equipment in either the same section or adjacent matching sections. Plug-in construction allows all units through 200 amps to be plugged onto the bus bars. The 400- and 600-amp units are bolted directly to the bus. Each switch unit is equipped with an interlock.

*Square D Company, 6060 Rivard St., Detroit 11, Mich.*



**For heating water, oils, tars, greases, plating baths, pickling solutions, etc.**

"Packaged" Chromalox Electric Heaters, combining heater and thermostat, are the economical, efficient solution to many heating problems. Uses include: heating tanks, drums and process kettles; melting greases, asphalts and similar viscous fluids; heating degreasing, pickling and plating baths. Available with sheaths of copper or steel, and with lead for use in corrosive solutions. Types, sizes and ratings to meet your needs.

**For all the facts get CATALOG 50**

It gives full data on thousands of time, money, labor-saving Chromalox Units.



Industrial Div., EDWIN L. WIEGAND CO., A-4443  
7637 Thomas Blvd., Pittsburgh 8, Pa.

Please send me free copy of CATALOG 50

Name \_\_\_\_\_  
Company \_\_\_\_\_  
Street \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_  
State \_\_\_\_\_

**CHROMALOX**

**ELECTRIC HEAT  
FOR MODERN INDUSTRY**



**RAWL-TAPERS**  
A machine screw anchor that fits the hole drilled, either by a new or worn drill.

**RAWL HAMMER-SETS**  
Heavy duty threaded type machine bolt anchor, (head out).

**RAWL LAG SHIELDS**  
For Solid Masonry. Rust Proof, durable alloy. For standard threads.

**RAWL ANCHORS**  
Thread out, for Holding Bolts Permanently. Heavy duty type. Two complete anchors combined in one.

**RAWLDRILLS**  
3 POINT EASILY SHARPENED MACHINED TYPE Rawl Twist for Hand and Power Drilling.

**RAWL-DRIVES**  
Bolt and Anchor in one piece—drives like a nail. Used only in hard materials, such as concrete, stone, etc.

**HOW DO YOU FASTEN THINGS TO MASONRY—WITHOUT CRACKING WALLS?**

**RAWL TOGGLE BOLTS**  
For anchoring any fixture or utility in hollow walls or ceilings.

**RAWLPLUGS**  
The ONLY universal screw anchor. The original jute fibre plug for wood, sheet metal and lag screws.

**LOOK AT THESE DEVICES. DID YOU EVER USE ANY OF THESE**

**RAWL-CARBIDE DRILLS**  
Spiral precision tool for top speed in rotary drill or hand brace.

## RAWL PRODUCTS?

Whether you have a junction box or a ten ton machine to fasten to masonry of any kind there is a RAWL PRODUCT to do the job—and do it better than any other device.

WRITE TODAY FOR CATALOG

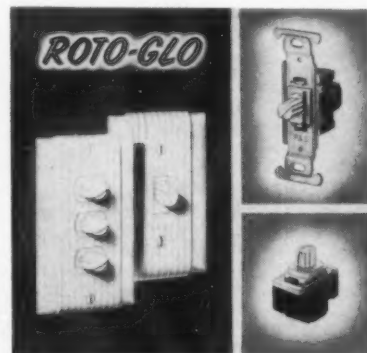
**THE RAWLPLUG COMPANY, Inc.**  
271 CHURCH STREET • NEW YORK 13, N. Y.



### Lighting Fixtures (4)

The newly designed Series "H" explosion-proof lighting fixtures are available in three styles—pendant, ceiling and bracket. Features are better light, safer light, streamlined, lightweight, easy relamping, wattage quickly changed on the job. Listed by Underwriters Laboratories, Inc. for Class 1, Groups C and D locations. Four sizes are available—100 watts, 150 watts, 200-300 watts medium base, and 300-500 watts mogul base; and four reflector types—standard dome, shallow bowl, deep bowl, and angle. Literature is available.

Killark Electric Mfg. Co., Vandeventer and Easton Avenues, St. Louis, Mo.



### Switches (5)

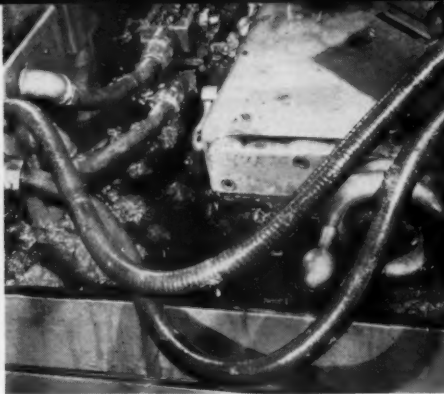
New Roto-Glo light switches are for use on ac circuits. They can be used to full current rating on incandescent and fluorescent (inductive) lighting loads, and on motors when the full load current is not more than 80% of current rating of switch. Switches are totally enclosed, have screwless terminals for quick wiring, and can be mounted in any position. Luminous boots are furnished as standard. Molded of luminous plastic, these boots require only a moment's exposure to light to glow all night long, pin-pointing the location of switches across any average room and using no electric current. Available in P&S Despard type for combination wiring, or conventional strap type. They are rated 15-amp, 120-volt, ac., 277-volt, ac; strap type, rated 15-amp, 120-volt, ac.

Pass & Seymour, Inc., Syracuse 9, N. Y.





Sealtite resists corrosive mixture of powdered calcium sulphate, magnesium oxide and magnesium chloride.



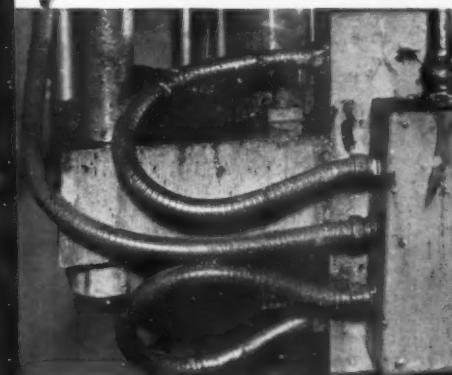
Sealtite protects grinder motor leads . . . flexes continuously under abrasive coat of metal dust, oil and coolant.



In paper mill's steamy air, Sealtite is covered with oil and wet pulp containing chlorine and caustic soda.

Give the dirtiest jobs to

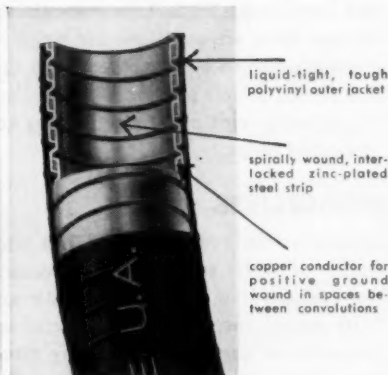
# SEALTITE flexible, liquid-tight conduit



Sealtite makes tight bends on hydraulic press, keeps motor leads free from oil, grease and water.



Sealtite keeps weather out of leads to outdoor pump motor.



liquid-tight, tough polyvinyl outer jacket

spirally wound, interlocked zinc-plated steel strip

copper conductor for positive ground wound in spaces between convolutions

Cutaway shows construction details of Sealtite Type UA.

Sealtite is made in two types. Specifications in table below. Type UA is approved by Underwriters' Laboratory for service in wet spots. Available in light gray as well as black.

Type EF meets JIC standards. Extra flexible . . . ideal for machine tool applications. Standard stock colors: black, and machine tool light gray at no extra cost.

## SEALTITE TYPE E. F.

Trade Size (In.)	INSIDE DIAMETER (Inches)		OUTSIDE DIAMETER (Inches)		Appr. Inside Bend Diam. (In.)	Est. Wgt. (Lbs. Per 100 Feet)	Feet Per Std. Coil
	Min.	Max.	Min.	Max.			
3/8	.485	.505	.690	.710	5	24.0	250
1/2	.620	.640	.820	.840	6	29.0	200
3/4	.815	.835	1.030	1.050	9	38.5	200
1	1.030	1.055	1.290	1.315	10	68.0	100
1 1/4	1.370	1.395	1.630	1.655	13	86.0	100
1 1/2	1.575	1.600	1.875	1.900	15	117.0	50
2	2.020	2.045	2.350	2.375	17	155.0	50
2 1/2	2.480	2.505	2.850	2.875	20	198.0	—
3	3.070	3.095	3.470	3.500	27	282.0	—
4	4.000	4.050	4.465	4.500	34	414.5	—

## SEALTITE TYPE U. A.

Trade Size (In.)	INSIDE DIAMETER (Inches)		OUTSIDE DIAMETER (Inches)		Appr. Inside Bend Diam. (In.)	Est. Wgt. (Lbs. Per 100 Feet)	Feet Per Std. Coil
	Min.	Max.	Min.	Max.			
3/8	.484	.504	.690	.710	8	30.0	200
1/2	.622	.642	.820	.840	10	36.6	200
3/4	.820	.840	1.030	1.050	15	48.2	150
1	1.041	1.066	1.290	1.315	18	87.7	100
1 1/4	1.380	1.410	1.630	1.660	21	116.5	50

Sealtite\* flexible, liquid-tight conduit gives wiring maximum protection against oil, grease, water, dirt, chemicals, corrosive atmospheres and weather. Nothing gets through its tough, polyvinyl outer covering. It stands up under continuous flexing . . . absorbs vibration, connects moving parts . . . connects misaligned outlets . . . prevents burn-outs. For long runs or short leads it's easy to install . . . saves the time it would take you to cut, bend and fit rigid conduit.

**ELECTRICAL WHOLESALERS** stock Sealtite in easy-to-handle coils. Buy it this way in long lengths . . . cut it on the job without waste. Your electrical wholesaler also stocks liquid-tight connectors. For more information write for Sealtite bulletins. Address *The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.*

\*Trade Mark  
†Pat. App. For

55162



**SEALTITE** FLEXIBLE, LIQUID-TIGHT CONDUIT

AN **ANACONDA**® PRODUCT

## NEW STEBER LIGHTING UNITS CUT INSTALLATION TIME AND COSTS

The Steber line, containing hundreds of lighting units and fittings, gives you a complete selection of durable, low cost matched units that simplify and speed every installation. Their greater adaptability assures specified lighting results as well as better appearance and lifelong satisfaction. Lighting units are fully wired with ample leads.

### STEBER FITTINGS

Versatile Steberlite fittings make all jobs easier, more economical, cut wiring time and installation costs. Lifetime cast aluminum units are available for single or clusters of up to 8 Steberlites. Each unit is designed to do a specific job better and fit perfectly with all Steber fittings and Steberlite units.

### STEBERLITES

Steberlites are available now in a wide choice of styles to meet your specifications exactly. No. S300 medium base and S350 mogul base provide universal adjustment for casting light in any direction. These units use medium or mogul base PAR-38 and R-40 sealed beam lamps. S400 accommodates PAR-56 Flood or Spot lamps. S500 is a chrome plated medium base Steberlite, using PAR-38 and R-40 sealed beam lamps.

### STEBER FLOODLIGHTS

Steber Floodlights are ideal for lighting parking lots, construction projects, shipping and receiving docks, service stations, railroad yards, sports areas and wherever economical high intensity is required. Available for 100 to 1500 watt lamps with or without lens. Full choice of styles and mounting bracket assemblies.

*Sold through leading wholesalers*

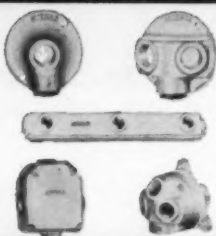
# STEBER

STEBER MANUFACTURING CO.  
OF CALIFORNIA  
242 S. Anderson St.  
Los Angeles 33, California

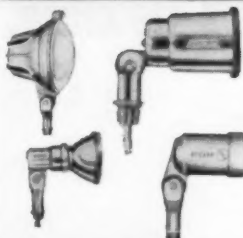
STEBER MANUFACTURING CO.  
Dept. 98  
Broadview (Maywood P.O.), Illinois

STEBER-WOODHOUSE, LTD.  
2368 Dundas St. West  
Toronto, Canada

### MATCHED UNITS MAKE THE JOB EASY



### STEBERLITES



### FLOODLIGHTS

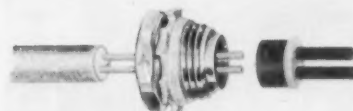


### HIGH BAY UNITS

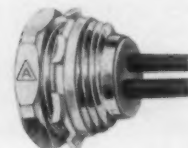


All aluminum construction prevents damage caused by corrosive atmospheres.

Write for complete Catalog TDS-9 containing information and prices on hundreds of Steber items!



Style 2 - "M.I." Connector - Unassembled



Style 2 - "M.I." Connector - Assembled

### Connectors

(6)

New "M.I." series connectors which simplify the installation of the newly introduced mineral insulated cable. The Style 1 connector for threaded conduit hubs consists of three brass parts and Style 2 for use in knockouts of steel junction boxes has one basic component. Available for use with MI cable ranging from size 16 to size 10, 2 conductor to 4 conductor. The units require no paste or compound to achieve a proper seal on the cable end, using instead a Neoprene "button" that is locked tight against the cable end by the tightening of a nut.

Appleton Electric Co., 1704 Wellington Ave., Chicago 13, Ill.



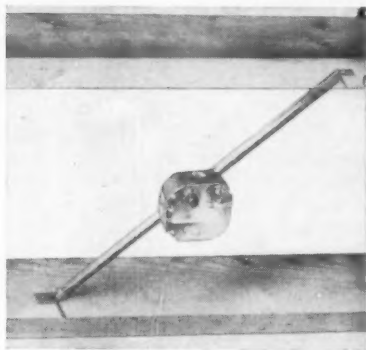
### Heat Pumps

(7)

A new line of packaged air-source heat pumps feature a more compact size and improved performance due to a more effective relationship between heating and cooling capacity. Key factor in the improved heating-cooling ratio is a unique modulated hermetic motor-compressor, designed specifically for heat pumps. The new Weathertrons are provided with panels that can be papered or painted to go with any room decor. Unit can be installed in recreation room, garage, attic, kitchen, living room, or out of doors. They can be built into wall if desired.

Floor space occupied by the new models is 9.8 sq ft. All models are housed in cabinets of identical dimensions for flexibility—29 by 48 by 74 inches. An air distribution plenum for inspace use on commercial and industrial units adds 10 inches to unit's overall height. Models are rated for 3 and 5 tons and designated WT44C and WT66C. The 44C models will heat and cool a 6- to 8-room standard house while the 66C will condition a 7- to 9-room deluxe house.

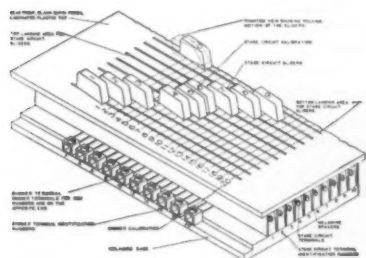
General Electric Company, Weathertron Department, Bloomfield, N. J.



**Fixture Hanger (8)**

A new bar-type fixture hanger, known as Kwikbar. It is one rigid steel bar requiring no length adjusting and no telescoping. The one bar fits all joist and stud centers, and has a self-measuring depth spacer giving correct allowance for wall thickness. It is suitable for old work as well as new, in ceilings or in sidewalls, as the side flanges can be nailed from either side.

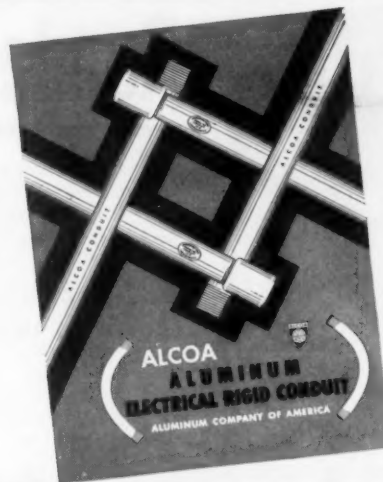
Kruse-Rieke, Auburn, Ind.



**Panel (9)**

A simplified method of connecting individual or combinations of stage lighting circuits to any of the dimming control circuits of a switchboard, called the "Quick-Connect" panel. Unit is designed for operation by non-professionals in schools, churches, hotels, service theatres, and night clubs. Cross-connection is accomplished with a series of vertical sliders connected to stage light circuits. It is available in console and wall models. Both units have 15 dimming constant circuits and 30 flexible stage circuits.

Ariel Davis Manufacturing Co., 3687 South State St., Salt Lake City, Utah.



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## Alcoa Book Gives You the Facts on the Lowest Cost Corrosion-Resistant Rigid Conduit!

Be ready with the answers when the question of corrosion-resistant conduit comes up! Come up with the right answer, the lowest cost answer: Alcoa® Aluminum Electrical Rigid Conduit.

You'll find all the facts on this lowest cost corrosion-resistant, non-magnetic rigid conduit in this book

published by Alcoa. Facts on applications, advantages, installation, and sizes. Send for your free copy, today. Have the facts at your finger tips when you need them!

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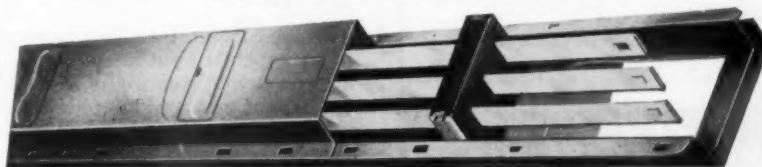
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**New Alcoa Aluminum Bus Conductor makes bus systems stronger, lighter; cuts costs!** Bus systems using Alcoa's new No. 2 EC bus bar provide the best combination of strength, light weight and conductivity at a saving of up to 10%. Specify Alcoa Aluminum Bus Conductor.



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Assure trouble-free wiring of:

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Precision machined from phenolic material, NEMA Class XX, Adalet insulating bushings are available for pipe sizes from  $\frac{1}{8}$  inch through 6 inches. Can be used on rigid or thin-wall conduit terminals, junction boxes, control cabinet knock-outs, etc.

Mechanically and dielectrically strong . . . moisture and oil resistant. Send for sample or:

*Request Bulletin A*

**THE Adalet MFG. CO.**  
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# Reader's Quiz

QUESTIONS from readers on problems of industrial equipment, installation, maintenance and repair. Answered by electrical maintenance engineers and industrial electrical contractors out of their experience. For every question and every answer published we pay \$5.00.

## Self-Excitation for Alternators

**QUESTION X27**—Has anyone successfully made a self excited alternator of any size by using the small generated ac voltage due to residual magnetism to start the buildup? Can it be done by connecting to the ac side of a rectifier and connecting the dc side of rectifier through a filter to get steady dc to the field of the alternator? What type of a rectifier and filter is best for this purpose?—E.B.

**ANSWER TO X27**—Yes, self-excited alternators have been made. A motor-generator set is usually the best type of rectifier for any appreciable load: probably the tungar bulb type should be second choice. These do not need any filters.

In this case though, the rectifier losses have to be deducted from the small starting power generated from residual magnetism, so it is likely to be slow in starting, and no doubt in some cases could fail to develop sufficiently. Then, too, if automatic voltage regulation is desired this increases complications.

The best method of self-exciting any alternator (where armature and fields have the same voltage) is with a commutator added to one end of the shaft, to obtain a true direct current, efficiently. Regulation can still have some complications, and much depends upon the size and purpose of the machine. There are several ac self-excited gasoline driven plants on the market, most of which use a commutator.—M.C.T.

**ANSWER TO X27**—Manufacturers many years ago stopped trying to manufacture self-excited alternators.

A present day development which was accelerated during World War II was the development of revolving permanent magnet ac exciters which in turn furnished dc to the alternator field when passed through a rectifier, selenium or equivalent type. The writer has knowledge of a unit rated 1.5 kw which was put in service some four years ago. Actually this type of exciter is of value as it has no collector rings and associated wiring and its construction permits high speed rotation.—C.O.D.

## Magnetic Core for Relay

**QUESTION Y27**—Can a Heusler alloy be used for the magnetic circuit of a high speed relay?—H.S.

**ANSWER TO Y27**—Oddly enough, the alloy developed by Dr. Heusler at the turn of the century was specifically patented at that time for just such an application—high speed relays.

Heusler's Alloy is composed of copper, manganese and aluminum, and possesses marked magnetic qualities. The permeability (the ratio of magnetic induction  $B$  to magnetic force  $H$ ) increases with the addition of manganese until the proportions of manganese and aluminum are the same relatively as their atomic weights. The maximum magnetization obtained, and their instant reluctance, is about one-third ( $\frac{1}{3}$ ) that of the best soft iron. Copper serves apparently no other purpose than to give malleability to the alloy for casting, machining, and easier forming. The particular combination found to exhibit best magnetic properties contains 14.3% aluminum, 28.6% manganese, and 57.1% copper.

According to Dr. Heusler, the most magnetic alloy, and yet the most reluctant (at rest), contained 25% of manganese, 12.5% of aluminum, and 62% of copper, or in the respective proportions of their atomic weights.

For further information, see: Bureau of Standards Bulletin, 1906, Vol. 2, No. 2; also Stephenson, Bulletin No. 47, Eng'g. Exp. Sta., Univ. of Illinois, 1910.—R.R.T.

## Transformer Regulation

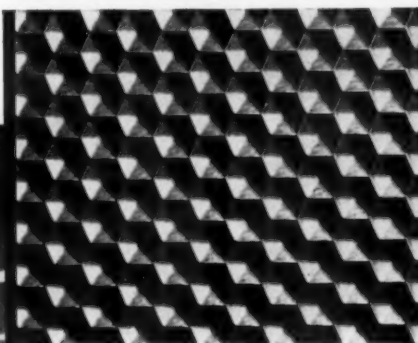
**QUESTION Z27**—One large transformer manufacturer sent specifications on a 2400/480-volt transformer, which we are about to purchase. One of the statements made was on regulation, which was 1.1% at full-load, unity power factor, and 3.8% at .8 power factor. Why the difference in regulation when the load remains the same?—M.D.



## ARCHITECT'S AND ENGINEER'S FACT SHEET

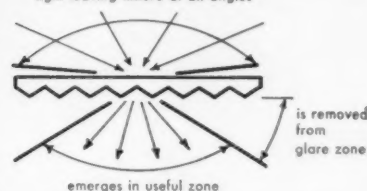


Photo—Ezra Stoller. Pattern 70 installation at the Manufacturers Trust Company's new Fifth Avenue Office in New York. Architects—Skidmore Owings and Merrill.



Close-up view of Pattern No. 70, a prismatic crystal lens panel. You can get Pattern No. 70 in widths up to 34 inches, lengths up to 100 inches.

light leaving fixture at all angles



Working diagram. Light enters panel from fixture (top) at all angles. Prisms gather light, transmit it to useful zone.

## CORNING PATTERN No. 70

### Lightweight . . . Low-Brightness Lens Panel

You use Corning Pattern No. 70 to deliver maximum light in the useful zone with low brightness in the glare zone.

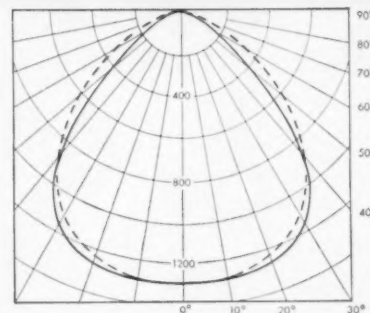
A pattern of hexagonal prisms on one surface controls the light. These prisms bend light rays downward creating more useful illumination. Light in the near horizontal angles is reduced so that surface brightness of the panel is low at normal viewing angles.

Result is a distribution of emitted light in a pattern of even illumination on the working surface.

Lightweight—just 1.75 pounds to the square foot. You can get panels up to 100 inches long—for one-piece fixtures that eliminate dust- and light-leaking seams. Water-white crystal, dimensionally stable glass. Won't warp, fade, discolor, or show age. Has no dust-attracting static charge. Cleans easily.

Recommended for luminous elements, troffers and fixtures in schools, banks, offices—*wherever* you want low brightness.

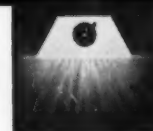
For free information about this interesting and useful lighting-ware, please use the coupon.



Candle power distribution

—Across axis ---Thru axis

Two 40-watt 3500° lamps (4960 lumens). White Enamel Reflector, 80% R. F., 11" x 48" segment. No. 70 Low-Brightness Lens Panel.



White Reflector and Pattern No. 70 Low-Brightness Lens Panel.



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Engineering improvements in the design and construction of ROYAL-NOARK cartridge fuses mean that they stay cooler... give greater protection to vital equipment.  
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ROYAL ELECTRIC CO., INC. PAWTUCKET, R. I.

ANSWER TO Z27—For a given constant kilowatt load, the line current is minimum when the power factor is unity. The current increases as the power factor becomes less, and at .8 power factor, the current has increased by 25% over its value at unity power factor. The regulation of a transformer depends on its internal voltage drop which in turn is equal to the product of the line current times the equivalent impedance of the transformer. Therefore as the power factor decreases, the product of the greater line current times the equivalent impedance increases, which means that the internal voltage drop of the transformer increases. This results in higher percent regulation for decreasing power factor for a constant kilowatt load.—F.J.T.

ANSWER TO Z27: Transformer regulation is the percent output voltage drop from no load to full load. It's the result of  $IR$  and  $IX^L$  (inductive reactance) drops in the transformer windings, so it will vary with power factor. As a matter of fact, since the load current varies with power factor, it is necessary to state the power factor whenever you state regulation.

Actually MD is incorrect when he says the load is the same at unity and .8 power factor. To the transformer the .8 power factor load is heavier than the unity load, although the actual wattage may be identical. The extra lagging current causes just as much heat and voltage drop in the transformer windings as though it were all actual load current, for it is kva and not kw that determines transformer capacity.—D.H.N.

**Industrial Lighting**

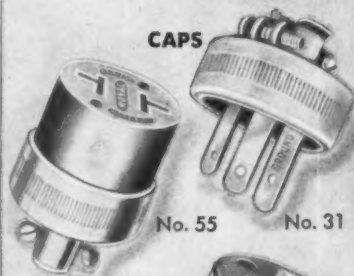
QUESTION A28—Can any reader suggest a good rule of thumb for choosing between fluorescent, mercury vapor, and incandescent lighting in industrial applications? It seems to be primarily a matter of mounting height, but it is difficult to know where the line should be drawn.—D.H.N.

ANSWER TO A28—Incandescent lights have a good color, first cost is low, any temperature is O.K., light output can be changed from less than 1-watt to 1500 watts by the customer and each socket is handy for an appliance.

Mercury vapor lights have a poor color for some jobs, first cost is high, will work on small temperature range, light output is fixed unless you use a 3-way switch, ballast can burn out, efficiency is very high.

**ROYAL****RIGHT CONTACT**  
for dependable  
wiring devices

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CONNECTORS

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**use them on  
EVERY JOB**

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RECEPTACLES



Sound engineering, quality materials, and experienced manufacturing skill make ROYAL wiring devices better for you these three ways: 1) they're easy to wire; 2) always dependable; and 3) long life under constant use.

... ask your wholesaler

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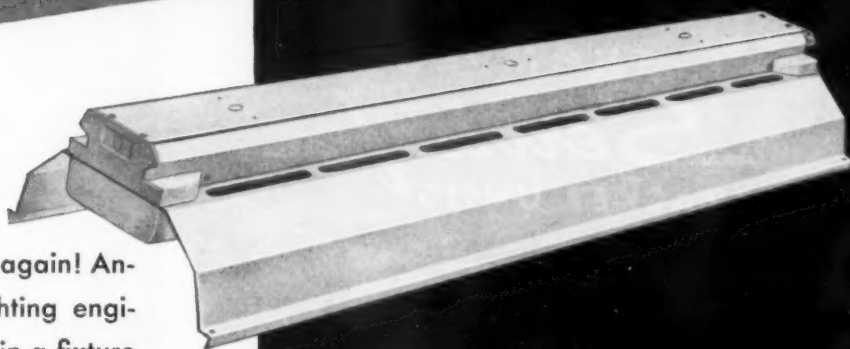
WIRE • CARTRIDGE FUSES  
famous ROYAL "Crystal" PLUG FUSES

ROYAL ELECTRIC CO., INC. PAWTUCKET, R. I.

# Wheeler "D" LINE

the "NEW LOOK"  
in **INDUSTRIAL LIGHTING**

New design features for better seeing.

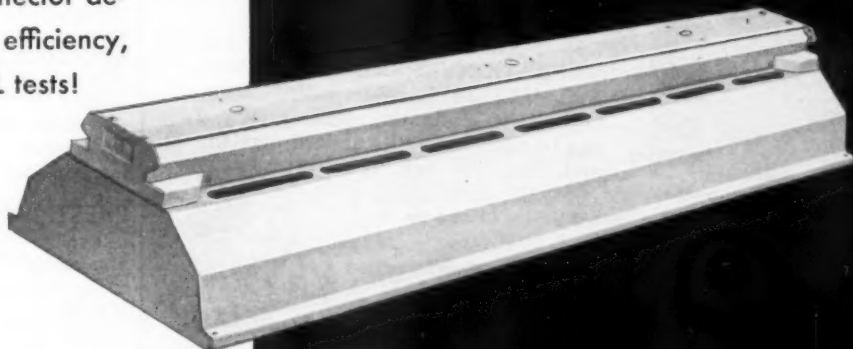


Wheeler does it again! Another advance in lighting engineering—interpreted in a fixture featuring typical Wheeler quality.

New Wheeler "D" Line fixtures provide more UPlight, approximately 12½% . . . greater protection for lampholders to minimize dirt and moisture problems . . . improved reflector design. Result — higher efficiency, actually proved by ETL tests!

## PLUS

all the extra quality features that have distinguished Wheeler lighting fixtures since 1881.



**Wheeler** REFLECTOR COMPANY

Distributed Exclusively through Electrical Wholesalers



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## GROUND LEVEL SERVICING OF OVERHEAD LIGHTS WITH

**THOMPSON**  
*Servisafe*  
**BRACKET UNITS**

HERE'S THE ANSWER TO LIGHTING MAINTENANCE PROBLEMS . . . for luminaires mounted on walls or wood poles. "Servisafe" Units permit fast, safe, low-cost servicing . . . assure all-weather accessibility . . . reduce luminaire maintenance to a simple hazard-free one-man job.

SUPPLIED IN COMPLETE PACKAGES\* . . . ready for wiring and erecting . . . "Servisafe" Units feature a patented disconnecting and lowering mechanism that permits workman to lower a luminaire . . . clean or relamp it . . . and then reposition it with minimum effort and complete safety.

FOR NEW INSTALLATIONS OR RAPID CONVERSION OF EXISTING FACILITIES, "Servisafe" Bracket Units have unlimited application . . . can be used with all standard pendant and flood type lighting fixtures.

\* Luminaires are not included in Bracket Unit packages.

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ADDITIONAL DETAILS.



- SAFER
- FASTER
- MORE ECONOMIC

**THE THOMPSON ELECTRIC CO.**

1157 Power Avenue • Cleveland 14, Ohio

Fluorescent lights have a good color, first cost is high, will work on small temperature range, light output is fixed, ballast can burn out, light source is big, efficiency is very high, does not need a shade.

I consider the first cost, and the number of hours the light will burn in a 5-year period.—H.S.

ANSWER TO A28—There are many more considerations than mounting height involved. Quality of light, continuity, and cost are very important. Probably incandescent installations are least expensive, from an installation standpoint, but are most expensive for power consumed. Fluorescent probably gives best quality light for reading and close work and is efficient, but installation and maintenance costs are high. Mercury vapor is highly efficient but the quality of light is rather poor. Also mercury vapor lights require time to restart after power failure, so should not be used alone.

Each application should be studied to get the quality of light required for that particular job at the lowest overall cost, considering installation, power required, and maintenance.—E.S.H.

### Can you ANSWER these QUESTIONS?

**QUESTION J28**—At present a 15 hp gasoline engine is pumping water from a well for spraying a commercial garden. What size electric motor is required to do the same job of about 300 gallons per minute? Motor type and hp will be appreciated and it must be single-phase.—M.B.

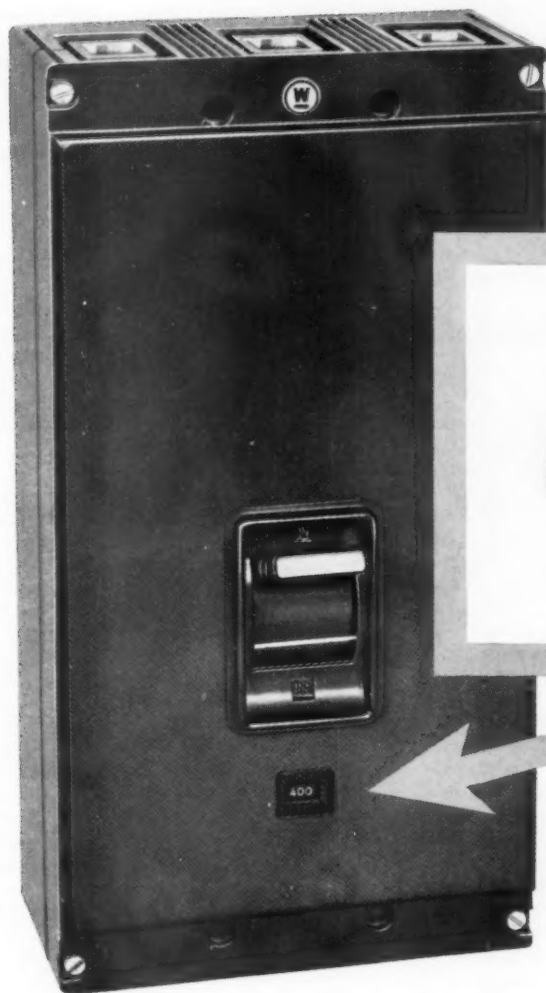
**QUESTION K28**—I understand type TW wire above 4/0 is not allowed in conduit due to cold flow of the thermoplastic insulation. Has any reader run a test and found that it is really dangerous to use these large cables in conduit?—H.S.

**QUESTION L28**—Do manufacturers of large size high voltage motors, 2300 to 4160 volts, generally varnish after the motor has been wound or is it sufficient to varnish the coils before they are put into the motor?—E.S.H.

**QUESTION M28**—I have a 3-phase 440-volt, 50 hp induction motor with a speed of 1750 rpm. How can I reconnect it to run at 1125-1150 rpm?—D.H.N.

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# Questions on the Code

Answered by

**B. A. McDONALD**, New York Board of Fire Underwriters, Rochester, N. Y.

**GLENN ROWELL**, Elect. Engr., Fire Underwriters Inspection Bureau, Minneapolis, Minn.

**B. Z. SEGALL**, Consulting Electrical Engineer, New Orleans, La.

## Motor Disconnecting Means

**Q.** I would like an interpretation of Section 4386, page 174 of the National Electrical Code.

The circuit of a 5-hp self-contained air-conditioner has at its disconnecting means a 30-amp Class A disconnect switch located at the main service. This switch is not within sight of the motor, but can be locked in the off position by a padlock. In my opinion, this switch would protect the service man working on this air-conditioner. I also feel this should satisfy the conditions stated in this article and the authority enforcing this Code. The air-conditioner is equipped with a double pole switch which disconnects to both lines to the starter, completely isolating the control circuit. This switch is used for turning the air-conditioner on and off. In my opinion both (A) and (B) of this article have been satisfied.

I was told I would have to install a safety switch in sight of the air-conditioner before the job would pass inspection by the authority enforcing this Code in St. Louis County. The City of St. Louis Inspection Department was contacted and they are in accord with the St. Louis County Inspection Department. This came as a surprise to me for I have been installing electrical equipment for 27 years and in some cases, where a motor is not within sight of the circuit disconnecting means no other switch was installed. In other cases a start stop pushbutton was installed at the motor location. In some instances this pushbutton was an ordinary start-stop pushbutton, in other cases a start stop pushbutton was installed with a locking device which depressed the stop button of the remote control circuit. I have wired many air-conditioners in the manner just described. I have also wired gasoline handling pumps this way; also a hydrogen plant, a grain elevator, an iron ore mill, a Tiff Mill. These jobs were all duly inspected and approved.

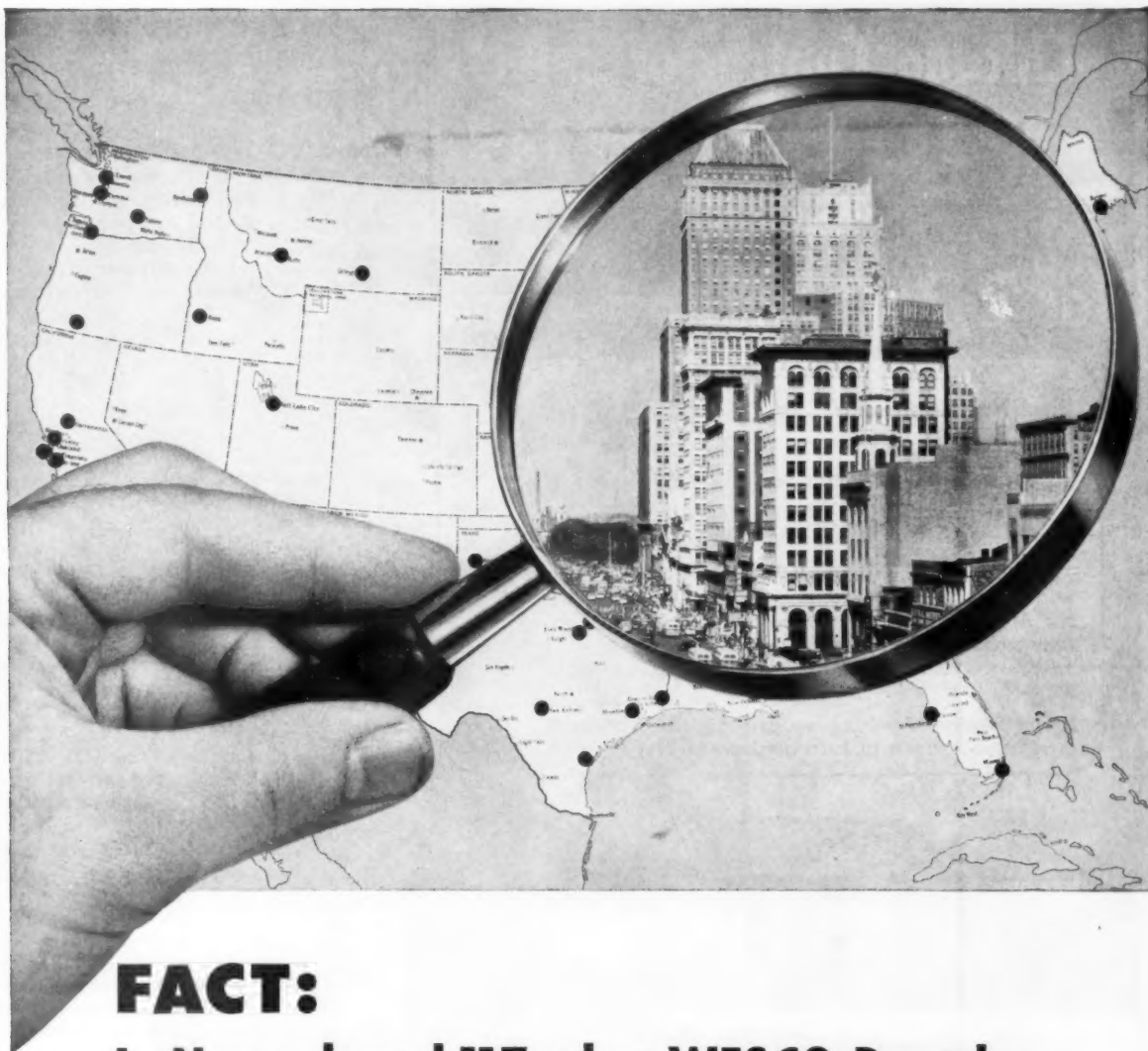
This article 4386 has been a part of the National Electrical Code for a long time, as I remember. Have I been misinformed all this time?—R.F.

**A.** The requirements of Section 4386 applies to the motor controller and not the disconnecting means for the motor and its controller which is covered by Sections 4401 to 4411. Section 4402 requires the disconnecting means for a motor to be a motor-circuit switch, rated in horsepower or a circuit breaker with several exceptions which do not appear to apply in the example presented. Section 4409 requires this disconnect to be within sight of the controller location or be arranged to be locked in the open position. Section 4386 requires a motor and its driven machinery to be within sight from the controller location unless the controller or its disconnecting means is capable of being locked in the open position. Other exceptions under this rule are also covered. It appears evident from the foregoing, under the conditions stated, that both the controller and its disconnecting means may be out of sight from the motor and its driven machinery when they are capable of being locked in the open position. I don't believe there is any question regards the position of the Code on this point.

There is a question, however, concerning the 30-amp disconnect switch located at the main service. If this switch is not rated in horsepower, it will not satisfy the requirements of Section 4402 for the disconnecting means for motors and controllers. It would therefore be necessary to either replace this switch by one with a hp rating or to install an additional switch rated in hp. Such a switch would bear the Underwriters' label reading "Enclosed Motor-Circuit Switch".

If the switch under discussion contains fuses, there could be a question with respect to the use of a 30-amp switch. A 5-hp, 3-phase, 220-volt motor, thrown across the line, would require 45-amp fuses unless fuses having time delay appropriate for the characteristics of the motor are used.

This, as far as I know, covers the N. E. Code requirements for the disconnecting means for motors and controllers. I do know that some people believe that a motor disconnecting means should be within sight from the location of the motor and its driven machinery.—B.A. McD.



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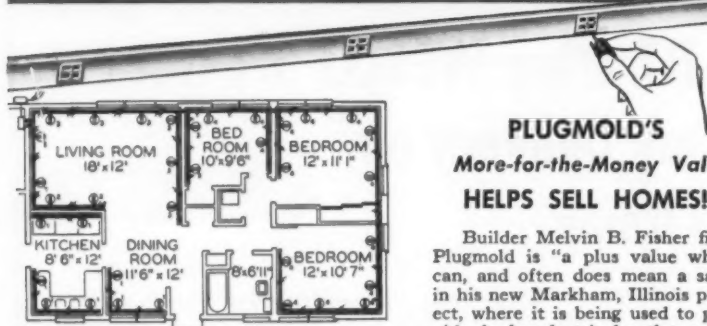
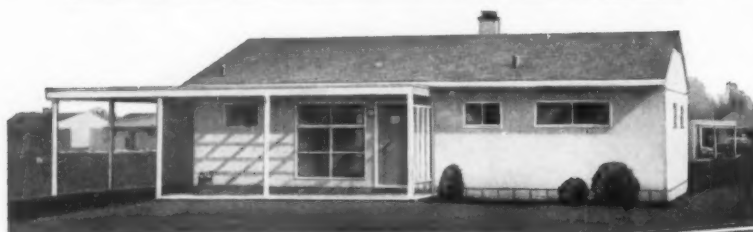
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## Service Entrance Conductors

**Q.** We are installing feeders to several different transformer locations spaced about the building in an attempt to provide better voltage control. These feeders will operate at 13,800 volts and as they must run in a horizontal manner for a considerable distance, we would like to place them within a metal trough or wireway. We plan to use individual conductors insulated for this voltage if such an installation is acceptable to the Code. —T.J.B.

**A.** Under Section 2387, you will note that in locations accessible to other than qualified persons, service entrance conductors of more than 600 volts shall be installed in rigid conduit or as multiple conductor cables approved for the purpose. If these are feeder conductors and not service, as you state in your letter, you will note under Section 7105 that such feeder conductors may be installed in rigid metal conduit raceways or ducts or as open runs of metal armored cable suitable for the use and purpose except that in locations accessible to qualified persons only open runs of nonmetallic sheathed cable, bare conductors and bus bars may also be used. Then inasmuch as this is undoubtedly an industrial installation where the rooms in which these feeders are run will be frequented only by persons employed on the premises, we wish to call your attention to paragraph b. under 7110 and also to Table 32, Chapter 10 where you will note you can isolate by elevation a feeder run of 13,800 volts by having a minimum vertical clearance of unguarded parts of 9 feet 3 inches. Therefore, if this plant can be considered a dry location, the Code would permit running these conductors in a duct or in the open if of metal armored cable, if multiple conductors are used, or if elevation of 9 feet 3 inches is used, they could be run on glass insulators as open conductors.—G.R.

## Auxiliary Conductors

**Q.** We are revamping some wiring in a rather large department store and plan to install a complete new service. As we are dividing this incoming service into five sections with five means of disconnect, we are using a gutter in which we wish to run all conductors. This gutter will be approximately 20 feet in length and will contain some 18 conductors. Must we derate the carrying capacity of





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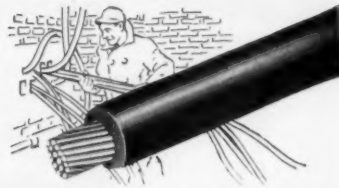
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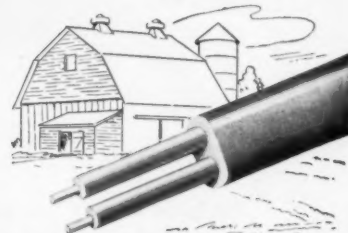
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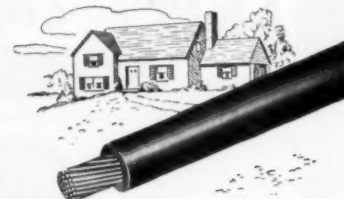
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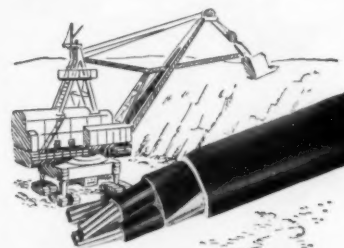
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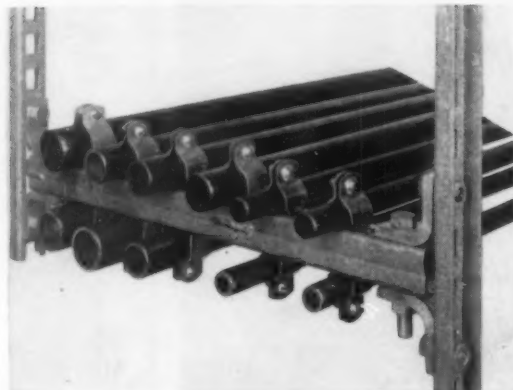


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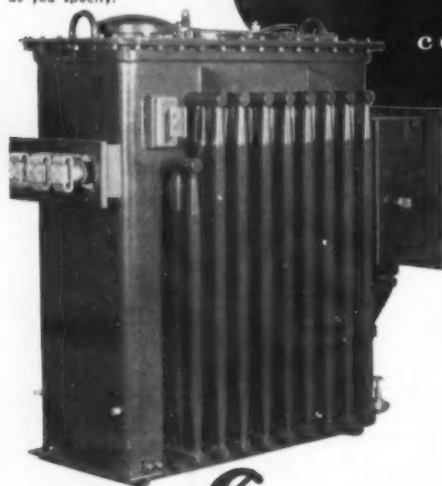
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these conductors contained within this gutter?—K.S.L.

**A.** Section 3745 of the Code states that auxiliary conductors shall not contain more than 30 conductors at any cross-section unless the conductors are for signaling circuits or are control conductors between a motor and its starter and used only for starting duty. The sum of the cross-sectional area of all containing conductors at any cross-section of an auxiliary gutter should not exceed 20% of the interior cross-sectional area of the gutter.

Then in a fine print note below this section you will note a statement to the effect that the correction factors specified in Note 4 of Table 1 of Chapter 10 are not applicable to the foregoing. I cannot advise you as to why this fine print note is contained in the Code. However, I can say that at the present time the National Electrical Code Committee is considering the removal of this fine print note and the inclusion of a requirement which will make mandatory the derating of conductors contained within a gutter just as they now require the derating of conductors contained in conduits.

Therefore, even though the Code would not require the derating of these conductors, I would strongly recommend that you derate them and would suggest you use not to exceed 65% of the values shown in Table No. 1 as I assume 15 of the 18 conductors are phase conductors and the other 3 are neutral. I do not, of course, know just what the Code Committee will finally accept as the percentages of current carrying capacity for various numbers of conductors in gutters. However, the present recommendation under consideration would indicate that the figure I have suggested is not too far off if you wish to assure a properly designed installation.—G.R.

### Grounding Circuits— Buildings Fed through Master Service

**Q.** In this area there are numerous bungalow colonies that are usually fed electric current from a central source.

If the bungalow is a duplex type then we use a MO 2 breaker, grounding the system to either a driven pipe or water line. The ground cable is bolted to the frame of the MO 2. Now if the bungalow is a 4-unit type, we use a 60-amp range box. The ground cable is grounded to the neutral block. What puzzles me is why in one in-

(ADV.)

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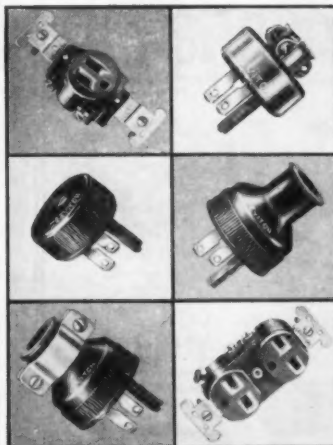
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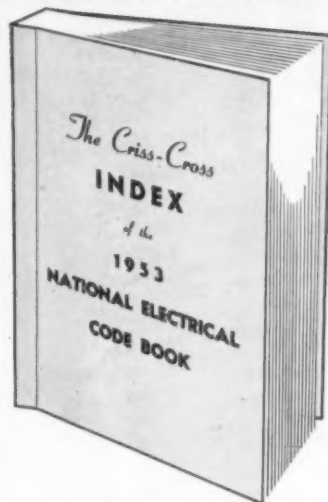
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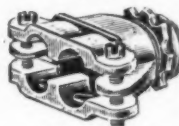
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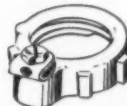
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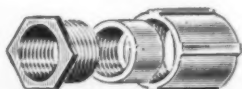
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stallation we have a system ground, grounding only the cable boxes, MO 2 box. In the other installation besides grounding the range box, cable boxes, we also ground our neutral conductor. Can you explain this difference?—D.W.

**A.** I assume from the first sentence of your question, that we have a group of bungalows, under single management and ownership, each of which are served electricity through a master service located in the building occupied by the owner or manager. It also appears that each bungalow of the duplex type would have a separate MO 2 breaker for each occupant and the 4-unit types would have a 60-amp range box for each unit.

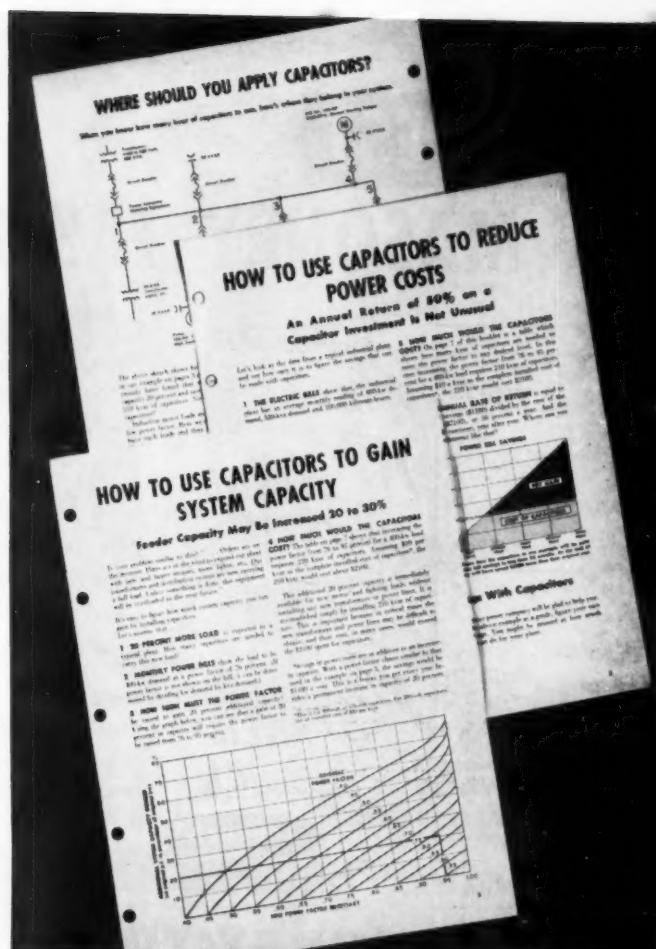
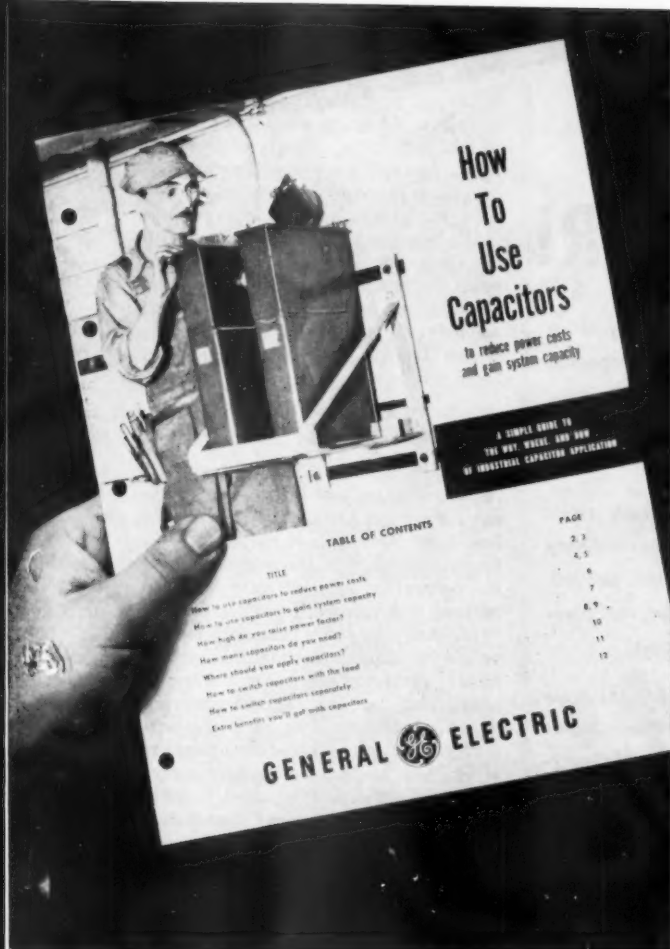
Section 2524 requires the service or feeder to any building which is served through a single or rather a master service, that has two or more branch circuits, to be grounded. This means that the system grounded conductor must be grounded at each building in addition to the ground connection where the service enters the main building. The metal equipment likewise must be grounded. It therefore appears that each of the bungalows served must have the circuit grounded conductor and the equipment grounded at each bungalow. If, however, an objectionable flow of current occurs due to the use of multiple grounds, as covered by Section 2521, the inspector might find it desirable to eliminate some of these ground connections. I do not believe any further detail with respect to the general installation would have any influence with respect to the requirements of Section 2524.—B.A.McD.

## Auxiliary Gutters

**Q.** We are having an argument with our electrical inspector concerning a wiring gutter which we had locally made to extend below a number of switches on a panelboard. The metalworker who made this gutter for us claims to have made a lot of other gutters of similar weight metal and says he has never had this question raised before. This gutter is about 7 by 10 inches, is 9 feet long and is made of No. 16 gage galvanized sheet steel. Is such construction contrary to Code requirements?—T.O.

**A.** Under Section 3749 of the Code, you will find a complete construction description of auxiliary gutters and in paragraph d. of that section you will see that gutters over 6 inches in any dimension, either





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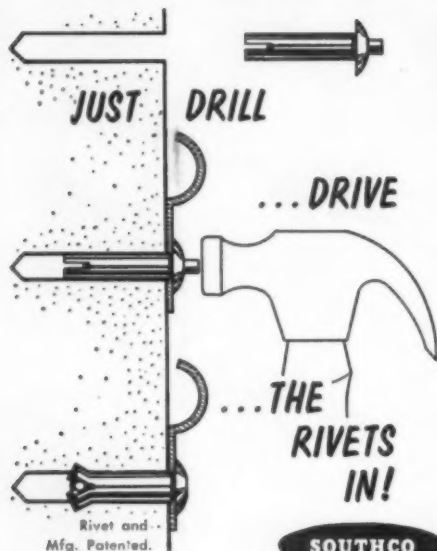
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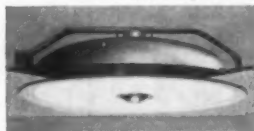
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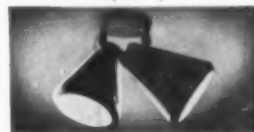
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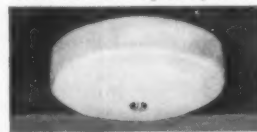
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Contemporary lighting creatively engineered

width or depth, must be made of at least No. 14 gage sheet steel. Then in addition, under item b. of this section you will note the necessity of providing corrosion protection so even though a gutter is made from galvanized sheet stock, full compliance with the Code would require application of paint or metal plating following the assembly to take care of raw edges, welded points, and all other places where the original galvanizing had been destroyed.—G.R.

## Crane Wiring

**Q.** In Section 6112a of the NEC it states that the current carrying capacity of conductors shall not be less than the full load current of the motor. Would good practice necessitate the percentage of nameplate full load current to be calculated under Section 4312a covering short time duty motors before the table in Section 6112a is applied? Is there any other governing regulations on the current carrying capacity of conductors in crane wiring? No limits of current capacities are given for contact conductors under 6112c. What would be good practice as to the size for various horsepower requirements on crane?—M.T.R.

**A.** Section 6112a does not state "the current carrying capacity of conductors shall not be less than the full load running current of the motors". This section covers three requirements with reference to the conductor sizes for cranes and hoists.

First, it permits a greater current carrying capacity for:

a. copper conductors with a rubber insulation, or

b. copper conductors with a thermoplastic insulation, than is usually permitted by Table 1 of Chapter 10. Thus a No. 14 Type RH insulated copper conductor may carry 20 or 22 amps depending on whether a 30/60 minute short time rating or a 5/15 minute short time rating, respectively, is applied to the crane motor. Table 1 shows a 15-amp current carrying capacity for this size of wire and type of insulation.

These crane and hoist motors do not require continuous use. Because of this intermittent duty it will be found that the conductors will not tend to heat beyond their rated temperature values even though they are overloaded (i.e., as in the above example the No. 14 carries 20 amps instead of 15) since the loads do not occur for protracted periods of time. Thus we may have an overload when first starting up the crane motor, the load may then decrease as the load pick up is accelerated and then it may finally be zero or a very small value at the point of the cycle when the load has been dis-

charged and the crane is idling.

One point should be kept in mind and that is, voltage drop considerations may have to be thought of and these may require that larger conductors be installed to permit proper operation of the crane and hoist motor. In general, the value shown in the table does permit the designer of approved equipment to obtain a solution of this problem of electrical systems for these cranes and hoist circuits that is practical, safe and economical.

The second requirement to be set forth in this section is the application of conductors having insulations other than rubber or thermoplastic. Thus Type MI cable may be used for crane wiring. As shown in Table 1, Chapter 10 this cable, for example in a 1/0 size has a rated current capacity of 155 amps. If used for a crane motor it may carry 10% more current or,

1.1 x 155 or 170.5 amps, in accordance with the second paragraph of Section 6112a.

The third requirement in the last paragraph covers specifications for the secondary wiring of wound rotor conductors by direct reference to the motor rule requirements set forth in Section 4312 covering wound rotor secondary circuits.

As indicated above, good practice would indicate that voltage drop considerations be kept in mind at all times. It is not necessary, however, to consider these conductor sizes first in the light of Section 4312a and then apply the values shown in Section 6112a. If voltage drop considerations will be acceptable for a particular installation with the current carrying capacities shown in Section 6112a then no further calculations will have to be made.

Section 6112c is only given to establish minimum span lengths commensurate with a safe factor of safety for mechanical considerations. It is quite possible that for an actual installation the crane motor may require smaller wires than shown in this table in Section 6112c but to insure the mechanical strength of the conductors the size may have to be increased. Thus, for example, while No. 10 conductors may be sufficient for the particular motor we have to install in accordance with the current values shown in the table in Section 6112a, if we install these on insulators spaced say every 50 feet, we would have to use at least a No. 4 wire, to satisfy the span requirements of the table in Section 6112c. Conversely, for example, the motor may require say a No. 1/0 conductor for proper size in accordance with Section 6112a. With these same 50-foot spacing supports we note that this is much in excess of the minimum size required by the table in Section 6112c so that this wire size would be satisfactory.—B.Z.S.



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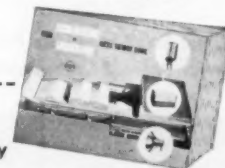
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# Modern Lighting

## Showroom Features Architectural Lighting

Olivetti, the Italian business machine manufacturer, has achieved a remarkable sales record in this country by identifying his products with the most up-to-date and progressive design practices. This policy has been advanced with the recent opening of the sumptuous new Olivetti showroom on New York's Fifth Avenue. Chaste modern lines and masses have been blended with rich green Italian marble, a sculptured wall of cast sand, a walnut door measuring 16-ft by 3½-ft, and unusual lighting treatments to create an architectural showpiece that will further associate the name "Olivetti" with excellence in design.

The lighting installation is of particular interest, for in addition to providing illumination and highlighting important architectural features, a third function has been delegated to it: patterns of light and colorfully decorated fixtures have become critical elements of overall motif of the interior.

Fluorescent coves at the ceiling lines of both side walls are employed to break up the large, relatively dark upper wall and ceiling area, while similar coves along the bases of the walls help to bring the focus of attention down to the display floor level.

The bright longitudinal lines of light from these coves serves the added purpose of complementing the face of the mezzanine which was painted white to give the impression of greater width to the store.

Business machines and typewriters are displayed on 12 marble stands scattered about the store. Each of these is spotlighted by an ornate luminaire suspended directly over it by steel wires. These units feature tapered cylindrical glassware with fused-in bands of color. The aluminum housing encloses a 12-volt Italian automobile headlight lamp.

The question of voltage drop on these 12-volt circuits presented quite a problem to the electrical contractors, MacNutt Electric Co., Inc., since the lighting panel is situated at the rear of the 85-ft-long store. The answer was obtained with a specially built transformer with several taps ranging from 12 to 18 volts. This unit was mounted adjacent to the panel and separate circuits run from each tap according to the length of the circuit.

The sculptured sand wall running the entire length of the room is highlighted by a single row of Century Eyeball Accentlites along the ceiling and another row under the mezzanine.



**FLUORESCENT COVES** at floor and ceiling lines break up room surfaces and direct interest to the display area. Colorful pendant luminaires spotlight business machines and typewriters mounted on marble posts.



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150-watt PAR-38 spots and floods are used in these units. The fixtures are not adjusted to provide uniform lighting on the wall, but rather to center interest on the important areas of the sculpture and to bring out the varying depths of the relief.

Additional general lighting for the showroom area was not deemed necessary since local illumination served all significant items—display mounts, writing tables, and the sculptured wall; moreover, with the exception of the doorway, the entire front of the room, from floor to ceiling, is glass.

For the salesmen's desks under the

mezzanine and the office area above, lighting is derived from Century Downlites. These recessed units have ellipsoidal Alzak reflectors which direct rays of light through a narrow aperture which cuts off high brightness in the normal line of vision. Silica-coated 100-watt lamps are used to increase uniformity of the illumination.

The total lighting effect complements and enhances the architectural style of the interior and provides practical utilitarian illumination designed to meet the seeing requirements in the office areas.

## Trans-Lighted Bank Ceilings Attract New Accounts

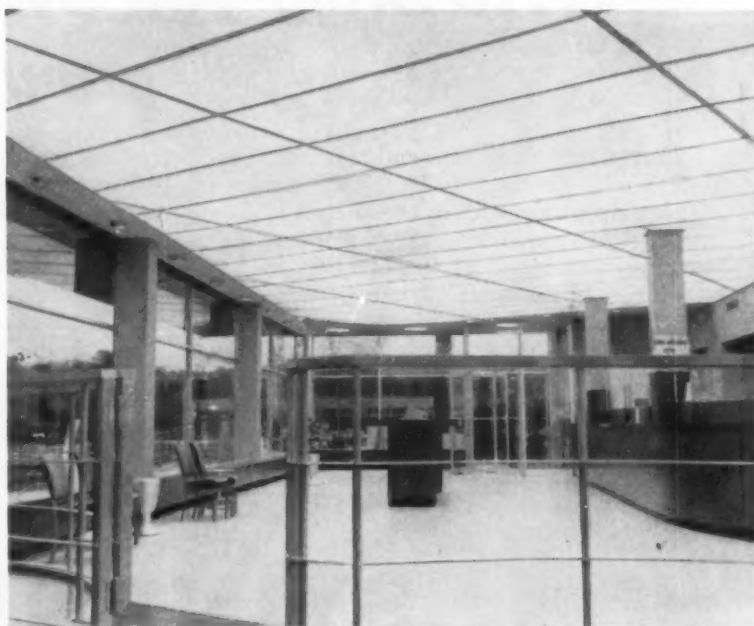
The Acusti-Luminus ceiling installed in the Cross-County Branch of the First National Bank of Yonkers, New York, deserves credit for a portion of the new bank's initial success in opening new accounts. The translighted ceiling, instrumental in making the bank a landmark after dark, is a natural attraction for customers.

The lighting system was installed over both the general banking area and the accounting room at a mounting height of 10 feet 6 inches above the floor. Sheets of corrugated Lumi-Plastic averaging 3x9 feet are supported on a grid of T-shaped metal border tracks. The lower surface of this plastic is flush with the acoustical tile forming the ceiling of adjoining areas of the bank which are lighted with recessed incandescent fixtures.

Instead of using sound baffles beneath the corrugated plastic, the top of the 14½-inch plenum was treated with an asbestos spray. Much of the noise of business operations passes through the acoustically transparent plastic and is absorbed within the plenum.

Lighting channels, mounted to the ceiling of the shallow plenum, contain 120-ma T-8 slimlines in lengths of 72 and 96 inches. An initial level of 50 ft-c was provided in the accounting area by 74 lamps mounted on 12-inch centers, a total of 570 sq ft. The 2660 sq ft of the general banking area uses 195 lamps on 18-inch centers, designed to produce 35 ft-c.

Electrical contractor Herbert G. Martin of Yonkers made the installation.



**GENERAL BANKING** area of the First National Bank of Yonkers features a trans-lighted ceiling hung with only 14½ inches of plenum space.

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A new Smithcraft development, the Pioneer is an attractive steel and plastic luminaire that gives a pleasing diffusion of light on top and sides yet permits a high transmittance of downlighting. Sides and top are formed of single extended plastic sections that meet the housing on top to completely enclose the unit. The Pioneer is available with steel louvers providing a shielding of 35° crosswise, 35° lengthwise, with plastic louvers providing 40° x 40° shielding, with Holophane Controlens® #9019, with Plastic Lucite Refractors, with Polycraft Plastic Dishes, with Corning Pattern #70 Glass. Pioneer is available for two, three or four Bi-Pin (Regular or Rapid-Start) or Slimline Lamps.

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## Smithcraft MERCURY

A popular, all-steel, louvered fixture available for two, three or four lamps in 4' Bi-Pin (Regular or Rapid-Start) or Slimline and in 6' and 8' Slimline. Mercury is general-diffuse in light distribution with self-illuminated side shields. Rigid louvers provide a cutoff of 35° crosswise, 25° lengthwise. (If desired, a cutoff of 45° crosswise, 45° lengthwise may be furnished at slight additional cost.) Louvers hinge from either side for simplified maintenance and can be completely removed without involving tools or loose parts. Side reflectors rotate upwards for easy cleaning.

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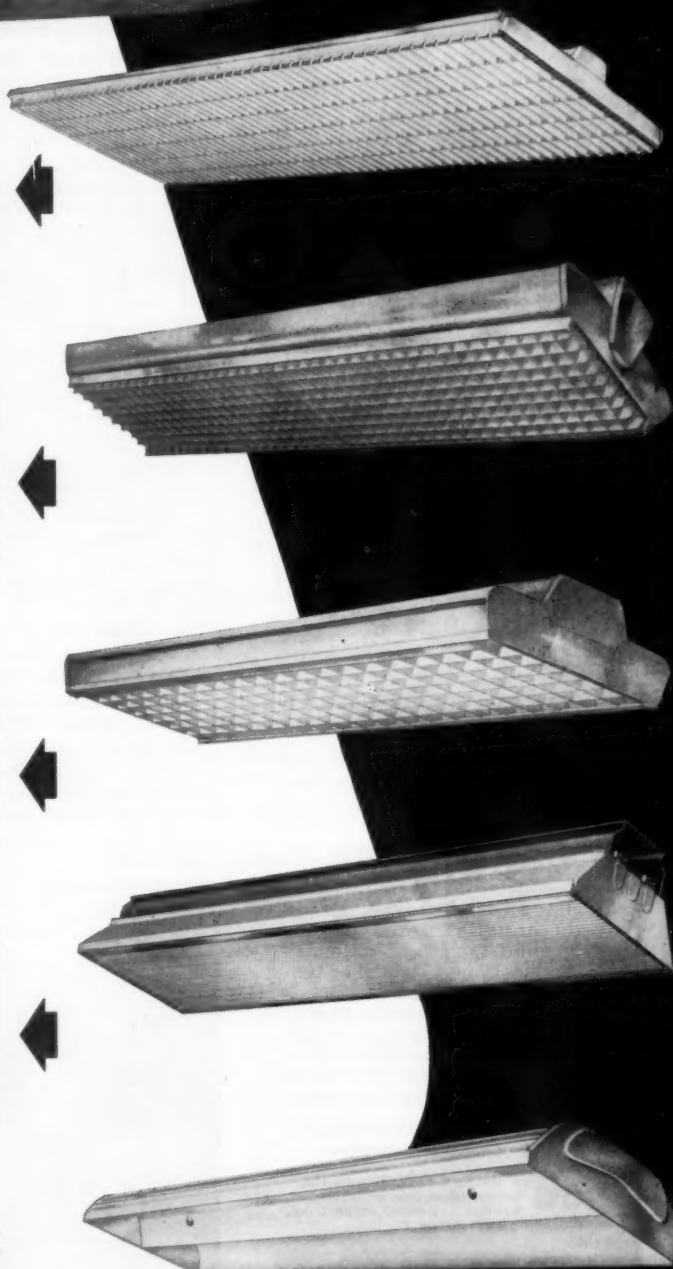
Combining the benefits of modern appearance, versatility, speed of installation and ease of maintenance, the Smithcraft Troffer can be installed in virtually any ceiling system (individually, in continuous rows or in pattern arrangements.) The patented Smithcraft Aligner Hanger actually saves up to one half of usual installation time and cost. Smithcraft Troffers are available for Bi-Pin Lamps (Regular and Rapid-Start) and Slimline Lamps in a wide variety of shielding components: Steel Louvers, Plastic Louvers, Ribbed Glass, Albalite, Curved Albalite, Plastic Lucite Refractors, Holophane Controlens®, Corning #70 Glass, Corning Fotolite and Polycraft Plastic Dishes.

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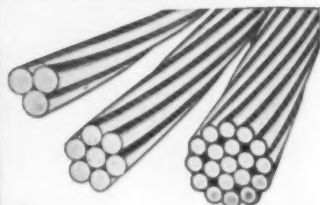


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## In The News

### Philadelphia IES Holds Contractors' Night

The Philadelphia Section of the Illuminating Engineering Society devoted its March meeting program entirely to electrical contractors and their activities in lighting. It was called "electrical contractors' night", and featured the presentation of miscellaneous cash prize awards, certificates, plaques, etc., for winning entries in the local 1954 Fall Lighting Campaign sponsored by the Philadelphia Electrical Association, and the presentation and discussion of the five first prize winning entries by the winning contestants. The meeting was well attended, with well over 100 electrical contractors and IES members present.

The Electrical Association's 1954 Fall Lighting Campaign, in which lighting equipment and lamp manufacturers' representatives also took part, offered prizes in five classifications. These were: Small Industrial, Large Industrial, Small Commercial, Large Commercial, and Exterior. A total of 15 prizes were awarded in these five classifications.

The electrical contractors who won the First Prize in each of the five lighting classifications each gave a short discussion of his winning lighting job. Each contractor used lantern slides to show the lighting installation and special lighting features, and discussed the highlights of the job.

The electrical contractors who won

first prizes, and the lighting installations winning the awards, were as follows: Small Industrial—Charles A. Holm, Prospect Park, Pa., on the W. Rose, Inc. plant at Sharon Hill, Pa.; Large Industrial—Jack Adler, Philadelphia, on the Acme Specialty Co. plant, Philadelphia; Small Commercial—Marshall Sabellico, Sabellico Bros., Downingtown, Pa., on Johnson's Jewelry Store, Downingtown, Pa.; Large Commercial—Robert M. Bates, Bates Bros., Primos, Pa., on the Nether Providence High School, Wallingford, Pa.; and Exterior—Herman Zatt, M. & H. Electric Co., Philadelphia, on the Courteous Motors display lot at Bala Cynwyd, Pa.

Following the contractor talks, the cash prizes and awards were presented to the 15 winners by Sherry Taylor, representing the Electrical Association. Winners were as follows:

**Small Industrial**—First Prize, \$75.00, Charles A. Holm, Prospect Park, Pa.; Second Prize, \$50.00, Thomas E. Atkinson, The Barney Roth Co., Philadelphia, Pa.

**Large Industrial**—First Prize, \$75.00, Jack Adler, Philadelphia, Pa.; Second Prize, \$50.00, Thomas E. Atkinson, The Barney Roth Co., Philadelphia, Pa.; Third Prize, \$25.00, Harry G. Hey, H. G. Hey Electric Construction, Hatboro, Pa.

**Small Commercial**—First Prize, \$75.00, Marshall Sabellico, Sabellico Bros., Downingtown, Pa.; Second Prize, \$50.00, Mahlon Miller, Phoenixville, Pa.; Third Prize, \$25.00,

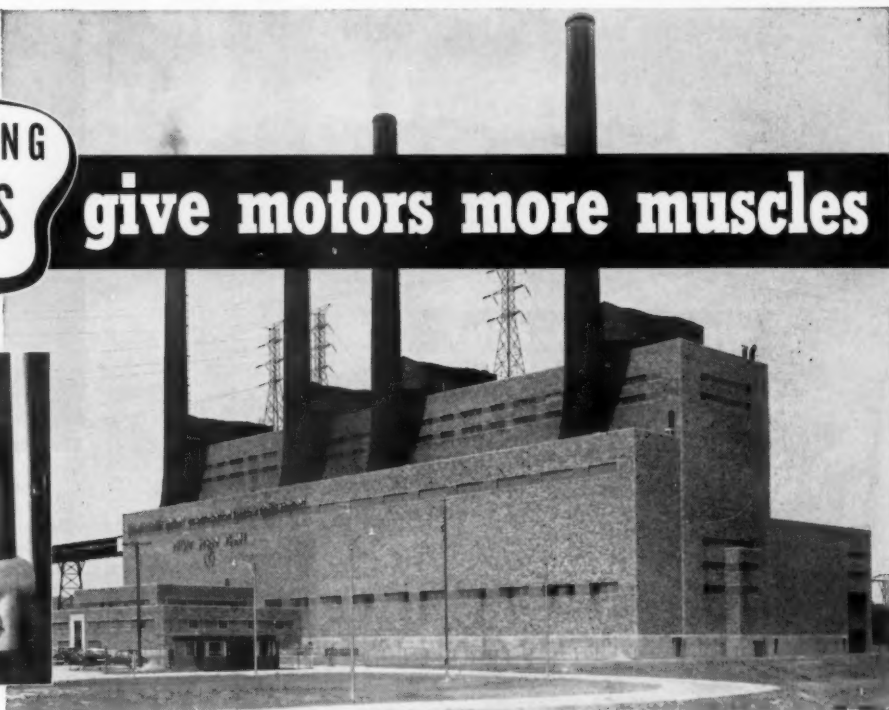
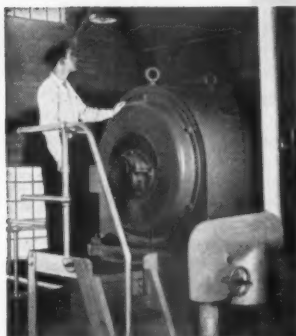


**FOUR ELECTRICAL CONTRACTORS** in Philadelphia won prize awards in the 1954 Lighting Competition, sponsored by "Electrical Construction and Maintenance" exclusively for contractors on a nation-wide basis, out of a total of 22 awards made nationally. They are (l. to r.): Charles A. Holm, Prospect Park, Pa., third prize in "industrial"; Courtland W. Frick, Glenside, Pa., third prize in "store"; Mahlon K. Miller, Phoenixville, Pa., first prize in "floodlighting"; and Milton W. Stratton, Independent Wiring Co., Philadelphia, first prize in "store." The awards were presented to the winning contestants by Berlon C. Cooper (right), Eastern editor of EC&M, at a recent "contractors' night" of the Philadelphia Section, Illuminating Engineering Society.



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Starting against cold air as many as 4 times a day, it is overloaded by 30% to bring its total rise to 120 C with a total output of more than 1300 hp. Built by the Elliot Company, the coils of this particular motor are wrapped with Silastic R Tape to give maximum vibration resistance.

Because it is smaller and easier to install than an equivalent 1500 hp conventional motor, it costs less to buy. And because it can safely carry the high initial loads, it operates at maximum efficiency with no power factor correction under normal loads.

You can also reduce to a minimum motor outages due to bearing failure by using Dow Corning 44 Grease

In open and single shielded bearings designed for high temperature operation, Dow Corning 44 has 8 to 10 times the life expectancy of conventional greases. It gives life-time lubrication in permanently sealed bearings.



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And what better proof could there be of the fact that Class H insulation made with Dow Corning silicones, saves money and increases the life, reliability and capacity of electric machines?

This experience also confirms the conclusions of another eastern utility, the Consolidated Edison Company who have long been buying Class H for major motors. For them, and for you, silicone insulation means more power and greater dependability — at less cost.

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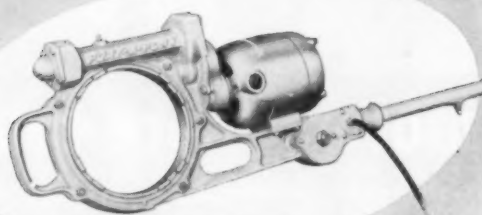
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Charles H. and Joseph B. Schaeffer, Carl I. Schaeffer Electric Co., St. Louis, Mo., relax after opening session of National Adequate Wiring Conference in Chicago. The Schaeffer firm has a fleet of 28 service trucks serving residential customers in the St. Louis area.

Herbert Leswing, J. & G. Electric Construction Co., Jenkintown, Pa.; Fourth Prize, \$12.50, Jacob H. Frater, Frater's Electric Service, Inc., Doylestown, Pa.

*Large Commercial* — First Prize, \$75.00, Robert M. Bates, Bates Bros., Primos, Pa.; Second Prize, \$50.00, R. Walcoff, Philadelphia, Pa.; Third Prize, \$25.00, Anthony Zangrilli, John Zangrilli Co., Pottstown, Pa.; Fourth Prize, \$12.50, Milton W. Stratton, Independent Wiring Co., Philadelphia. *Exterior*—First Prize, \$50.00, Herman Zatt, M. & H. Electric Co., Philadelphia, Pa.; Second Prize, \$25.00, Charles A. Holm, Prospect Park, Pa.

In addition to cash awards, all First Prize winners were also presented with a replica of the first Edison incandescent lamp, in commemoration of the 1954 Light's Diamond Jubilee.

Two Diamond Jubilee plaques were awarded by the Electrical Association for outstanding cooperation during the year 1954 by electrical contractor organizations. The city organization receiving this plaque was Independent Wiring Co., Inc., Philadelphia, while the suburban organization was Charles A. Holm, electrical contractor of Prospect Park, Pa.

The IES chairman, W. McCouch, presented an IES Past Chairman's certificate to Roland Hoot, who served as chairman of the Philadelphia Section for the fiscal year 1953-54.

Mr. McCouch next introduced A. S. Turner, of the G. E. Lamp Department, Philadelphia, who presented a history of the 1954 Light's Diamond Jubilee Illuminating Engineering Society National Technical Conference to Homer A. Manwaring, who was President of the Society during its

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30 to 600 AMP.

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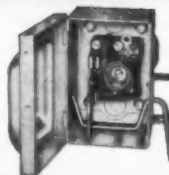
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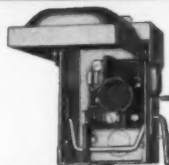
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1/2" HUB

National Conference in Atlantic City last September.

W. P. Graham of the Philadelphia Electric Co. next introduced Berlon C. Cooper, Eastern Editor of *Electrical Construction and Maintenance*, who presented Awards to four Philadelphia area electrical contractors. These Awards had been won in the magazine's 1954 Light's Diamond Jubilee Lighting Competition for Electrical Contractors. These Awards and their winners were: First Prize in Store Lighting, \$100.00 and Award Certificate, to Milton W. Stratton, Independent Wiring Co., Inc., Philadelphia, Pa., for his lighting installation at Paul F. Klinefelter, Inc. store, Philadelphia, Pa.; First Prize in Floodlighting, \$100.00 and Award Certificate, to Mahlon K. Miller, Phoenixville, Pa., for his lighting installation at used car lot of McCausland Motors, Inc., Phoenixville, Pa.; Third Prize in Store Lighting, to Courtland W. Frick, Glenside, Pa., for his lighting installation at George Parkhouse & Sons food market, Abingdon, Pa.; and Third Prize in Industrial Lighting, to Charles A. Holm, Prospect Park, Pa., for his lighting installation at Sorensen Industries, Darby, Pa.

## NECA to Hold Exposition

The first National Electrical Exposition will be held at the Waldorf-Astoria Hotel, New York, October 31 through November 2, 1955, in conjunction with the 54th Anniversary Convention of the National Electrical Contractors Association.

In announcing the plans for the Exposition, Paul M. Geary, executive vice president of NECA, said that this will be the first exhibit of electrical materials, equipment, apparatus and tools at a NECA Convention in almost 20 years. Approximately 2500 electrical contractors and their guests are expected to attend the Convention and since the Exposition will be open to the public it is believed that the attendance at the displays will be several thousands. The Exposition is to be held each year in connection with the NECA Convention.

The Exposition will feature the latest developments in electrical materials, equipment and apparatus used by electrical contractors in new electrical construction and modernization for the home, factory, store, school, public buildings, hospitals, marine and public works. The range of products will cover applications of electrical use to light, heat and power.

The Exposition will open its doors



**3**

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for the  
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formally in the third floor exhibit halls of the Waldorf-Astoria at 7:30 p.m. on Monday evening, October 31. The exhibits will open at noon on Tuesday, November 1, and remain open until 6 p.m. On November 2, the exhibits will open at noon and remain open until 10 p.m.

## Chicago Contractors Spark Wiring Promotion

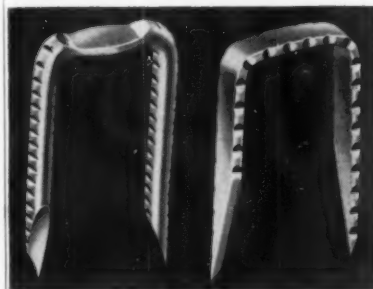
It has long been said, and acknowledged in many instances, that no wiring promotion can succeed without the active support of the electrical contractor. The electrical industry in Chicago is fully aware of this fact and determined that its five-point better wiring program, developed and coordinated through the Electric Association, will not falter on this score. This was evident at the recent Better Wiring Conference when the Association reviewed progress to date and future plans.

The Chicago promotion is built around electrical contractor leadership. Four of the six working committees are headed by contractors specializing in the specific activity involved. The other two, comprising educational activities and coordination of the complete promotion, are under the direction of industry men capable of directing all efforts to a common goal.

Emil DeHaan, vice president, Service Electric Company, is chairman of the Adequate Wiring for New Homes Committee. Through the efforts of this committee, Certified Adequate Wiring in new homes in Chicago reached an all-time high in 1954—a 414% increase over 1952 when the Certification Program was developed. Last year, the committee reported, some 23 home builders included Certified AW in 100% of the homes they built for resale. Sixteen electrical contractors (since Jan. 1953) have installed Certified AW in 50 or more new homes. Some of these have up to 350 certifications to their credit. And the local FHA regional office and local financing agencies have recognized the value of Adequate Wiring by increasing home and loan valuations accordingly. To help contractors and builders, The Electric Association has printed and distributed a residential handbook of Certified Wiring Standards for Chicago and Northern Illinois. The guide, approved by the NAWB, spells out AW requirements with specific references to the Chicago Electrical Code sections to differentiate between safety and adequacy standards.

Edward H. Wigdahl, president, Wigdahl Electric Company, is chair-

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man of the Home Wiring Modernization Committee. His group is working to open up an estimated \$200 million market in home rewiring—an average of \$200 per home needed in more than a million single family dwellings in the Chicago area. Last year, this committee initiated an experimental Pilot Project to learn how to sell this market (EC&M, Mar. 1954, pg. 202). From this experience came the Package Wiring Plan for 100-amp capacity electrical service and the recent Commonwealth Edison Company share-cost rewiring program (EC&M, Feb. 1955, pg. 193). Expansion of this plan was announced at this meeting. From now on, the Edison Company will finance residential rewiring up to \$200 if the customer meets the present 2-wire service eligibility requirement and the wiring meets the plan specifications. The customer must pay the full rewiring cost but need not purchase or have a 240-volt appliance to secure time payment privileges. However, if the customer does purchase or have such an appliance for connection, the Edison Company will pay up to \$35 for the service entrance according to the original plan.

T. L. Hankins, president, Condo Electric Company, heads the Apartment House Wiring Modernization Committee. Since 80% of Chicago and suburban population live in apartment buildings—many of them with totally inadequate electrical systems—this committee faces a tremendous rewiring market. To date, this group has met with apartment house management firms to discuss methods of upgrading apartment house wiring. Committee reports indicate definite wiring standards have been established, including sufficient feeder capacity to provide  $1\frac{1}{2}$  watts per square foot of floor area (including corridors) for air conditioning loads. Apartment house management firms are cooperating with the committee in conducting a direct mail promotional campaign and personal contact approach to owners and managers.

George Bard, executive vice president, Kelso-Burnett Electric Co., is chairman of the Commercial-Industrial Electrical Usages Committee. Bard's group is assigned the task of beaming a direct mail campaign to commercial and industrial users of electricity to encourage still greater use of electrical power and electrical equipment. A program of six mailings per year to all plants with 30 or more employees is now planned. These brochures will emphasize increased productivity, lower unit costs, and reduction of rejects through use of high intensity lighting, electric heating and drying, use of rectifiers for conversion to direct current, closed cir-

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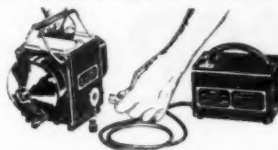
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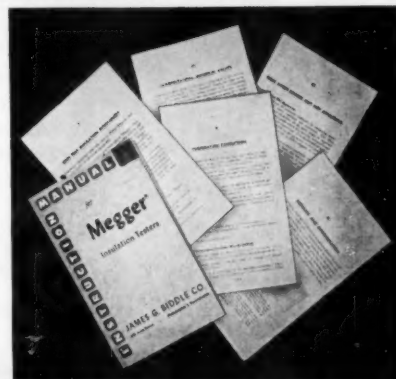
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cuit television for better production coordination and control, ultrasonic cleaning of materials, and application of automation to production processes.

B. H. Boatner, Chicago district manager, apparatus and supplies, Westinghouse Electric Supply Corp., is chairman of the Educational Committee. Boatner, who firmly believes the electrical contractor is the key to any successful wiring promotion, will have his group develop educational programs beamed at the homemaker, home owner, builders, engineers, business men, industrialists, and members of the electrical industry.

H. C. Moses, Jr., Chicago district manager of The Thomas & Betts Company, and vice president of the Electric Association, is general chairman of the complete program.

## NYC Acts to Meet Electrical Expansion

A three-part program designed to step up operational efficiency has been initiated by New York City's Department of Water Supply, Gas and Electricity. Record construction activity and the increasingly dangerous load growth in long outmoded tenement wiring systems necessitated an appreciable expansion of Dept. facilities, but New York's desperate budget situation precluded appropriation of additional funds.

Faced with this dilemma, Chief Engineer Albert Lorch set up a plan to meet the threat to safety and to improve municipal regulation of electrical installations.

Participation in Mayor Robert Wagner's pilot survey project constitutes the first element of the program. This undertaking consists of detailed re-examination of specified slum areas by electrical inspectors as well as representatives of the Fire, Health, and Building Departments.

Owners are warned of unsafe conditions by the inspectors. If these are not heeded, a notice of violation is posted. Failure to amend may then be followed by an order to disconnect service.

Close follow up of violation notices has been maintained by the Dept., according to Mr. Lorch. He feels that although this slows the progress of the survey, the resultant clearance of hazards to tenant safety more than warrants the extra work for the Dept. Despite its necessarily limited scope, the survey has emphatically confirmed the urgent need for modernization of the wiring in a vast number of New York's residential buildings.

## NISA News

New York Metropolitan Chapter held its regular meeting at Hotel Shelburne, New York, on March 17. Annual election of officers took place and the following were elected: H. Engelmann, Chairman; W. Kaupert, Vice Chairman; W. Leirer, Treasurer; and Joe Previte, Secretary. Members of the executive committee—R. Mallet, J. Ryan, W. Wheeler, R. Potter, A. Shovan, S. Bojak.

Louis D. Kennedy, executive secretary of the chapter, resigned and Joe Previte, newly elected secretary, formally took his position at this meeting.

A new NISA region, No. 16, was approved 195 to 1 by mail ballot last month. Region 16 is composed of Washington, Oregon, Idaho, Montana and Alaska.

Members of the new region have received ballots to elect a director.

The region was part of Region 14, which now includes California, Nevada and Hawaii. Carl Lundberg, Cascade Machinery Co., Seattle, Wash., currently is serving on NISA's board as a director-at-large.

Timely technical topics and informative business subjects are on tap for the coming NISA Convention. Speakers signed-up to-date include:

Ray Welborn, Jr., J & J Armature Works, Beaumont, Tex., "Harmonics in A-C Motors"; Joseph F. Ferrari, Excel Electric Service Co., Chicago, "Rebuilding Standards"; Ralph W. Trobaugh, Egle-Trobaugh Electric Co., Memphis, Tenn., "Hermetic Motors from the Repair Shop Point-of-View"; Earl S. Brooks, United Electric Motors, Seattle, Wash., "Operation of Small Motor Shops"; Dr. Joseph C. Hogan, associate professor of electrical engineering, University of Missouri, "Phase Converters"; George Treiber, sales manager, John C. Dolph Co., Monmouth Junction, N. J., "Fire Prevention"; Paul M. Sievert, Chicago, "Group Insurance"; Selden F. High, The Sullivan Electric Co., Cincinnati, Ohio, "Review of Sales Survey"; and Charles Sidway, Southern California Edison Co., "American Institute of Electrical Engineers' Classification of Insulation Grades".

Mel. H. Langford of Linde Air Products, who recently addressed the joint meeting of St. Louis and King Coal Chapters of NISA, appeared before the Los Angeles Chapter February 9 to discuss silicones and their uses in motor repair shops.

From Walter J. Prise, Queens Electric Motors, Inc., Jamaica, L. I., N. Y.



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## Dates Ahead

Illuminating Engineering Society —  
Regional Conferences: Canadian—  
East Central—Abraham Lincoln Hotel,  
Reading, Pennsylvania, May 19-20; and  
Northeastern—Fort William Henry Hotel,  
Lake George, New York, June 10-11.

National Fire Protection Assn.—59th  
annual convention, Netherland Plaza  
Hotel, Cincinnati, Ohio, May 16-20.

National Association of Electrical Distributors—47th annual convention,  
Conrad Hilton Hotel, Chicago, Ill.,  
May 22-25.

National Industrial Service Assn.,  
Inc.—Annual convention, Hotel Statler,  
Los Angeles, Calif., June 6-10.

Edison Electric Institute—Annual  
convention, Los Angeles, Calif., June  
13-16.

New York State Association of Electrical  
Contractors and Dealers, Inc.—  
Annual convention, Saranac Inn,  
Saranac Inn, N. Y. June 27-July 1.

Western Plant Maintenance Show—  
Los Angeles, Calif., July 12-14.

Illuminating Engineering Society—  
National Technical Conference,  
Statler Hotel, Cleveland, Ohio, September  
12-16.

National Association of Electrical Distributors—Pacific Zone, annual  
convention, Empress Hotel, Victoria,  
B. C., Canada, September 25-28.

International Association of Electrical  
Inspectors—Western Section, annual  
convention, Hotel Nicolet,  
Minneapolis, Minn., September 26-28.

Electrical Progress Show—Convention  
Hall, Philadelphia, Pa., September  
27-29.

National Electronics Conference—  
Hotel Sherman, Chicago, Ill., October  
3-5.

National Electrical Industries Show—  
69th Regiment Armory, New York  
City, October 11-14.

N. J. Council of Electrical Leagues—  
19th convention, Atlantic City, N. J.,  
October 14-15.

National Electrical Contractors Association—Annual convention,  
Waldorf-Astoria, New York City,  
October 31-November 4.

Fifth Industrial Electric Exposition—  
Hotel Wm. Penn, Pittsburgh, Pa.,  
November 1-3.

National Electrical Manufacturers  
Assn.—Annual meeting, Traymore  
Hotel, Atlantic City, N. J., November  
14-18.

American Institute of Electrical Engineers—  
Winter general meeting,  
Hotel Statler, New York, N. Y.,  
January 30-February 3, 1956.

Independent Electrical Contractors  
Assn., Inc.—Annual dinner and  
dance, Hotel Biltmore, New York,  
N. Y., February 11.

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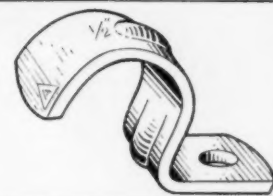
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## ATTENTION....EMPLOYMENT ADVERTISERS!

Effective with the July issue, a new section will start in **ELECTRICAL CONSTRUCTION AND MAINTENANCE**. We will head this section: **EMPLOYMENT OPPORTUNITIES**. All Displayed Employment Opportunity advertising will be placed in this new section, except ads contracted for run-of-book position. New advertisers will be billed at the rate of \$17.00 per inch, unless on contract. Advertisements are subject to Agency Commission.

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H. E. Hilty, Mgr.

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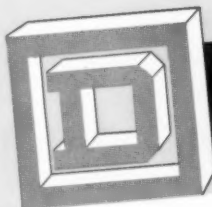
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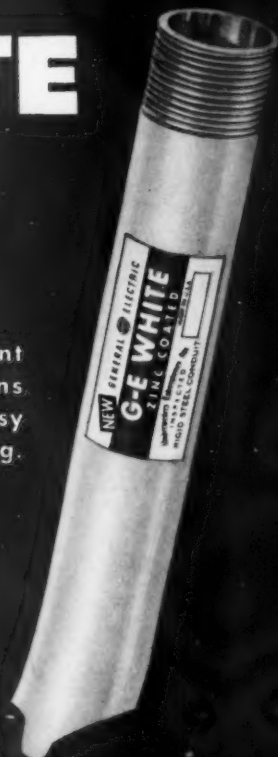
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